DETAILED SOLUTION

CSIR NET Life Sciences

June 2024 Shift 2

PART - A

June 2024 Shift 2

If liars always lie and truthful persons never, and in a group of 10 persons everyone calls all others liars, then the number of liars among the 10 is

1. 10
2. 9
3. 5
4. 1

Answer 2

There is just one person telling the truth calling all 9 others liar. This is consistent with the fact that rest 9 (which are liars) are calling everybody else liar, which is a lie.

A chess board contains 64 squares of 5 cm size, in 8 rows and 8 columns, alternately black and white. What is the total length of edges (in m) between the squares in the chessboard?

1. 2.8

2. 3.2

3. 5.6

4. 6.4

Answer 3

There will be 7 horizontal and 7 vertical lines (leaving the outer edges, as per question) so as to have total 64 squares.

Total vertical line length = 7 × Length of one line (5 × 8 = 40) = 7 × 40 = 280 cm = 2.8 m

Total horizontal line length = 7 × Length of one line (5 × 8 = 40) = 7 × 40 = 280 cm = 2.8 m

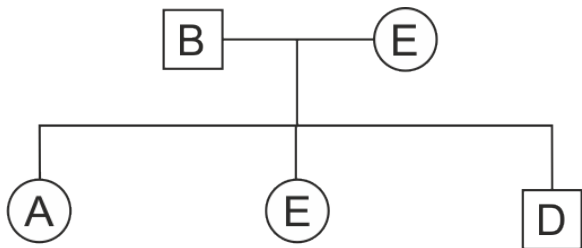Total length of the edges = 2.8 + 2.8 = 5.6 m

In a family of two males and three females, A is the daughter of B and sister of C. E is the spouse of B and mother of D. C is not the brother of D. Which of the following statements is NOT correct?

1. E is the mother of A

2. D is the sister of C

3. C is the daughter of B

4. A is the sister of D

Answer 2

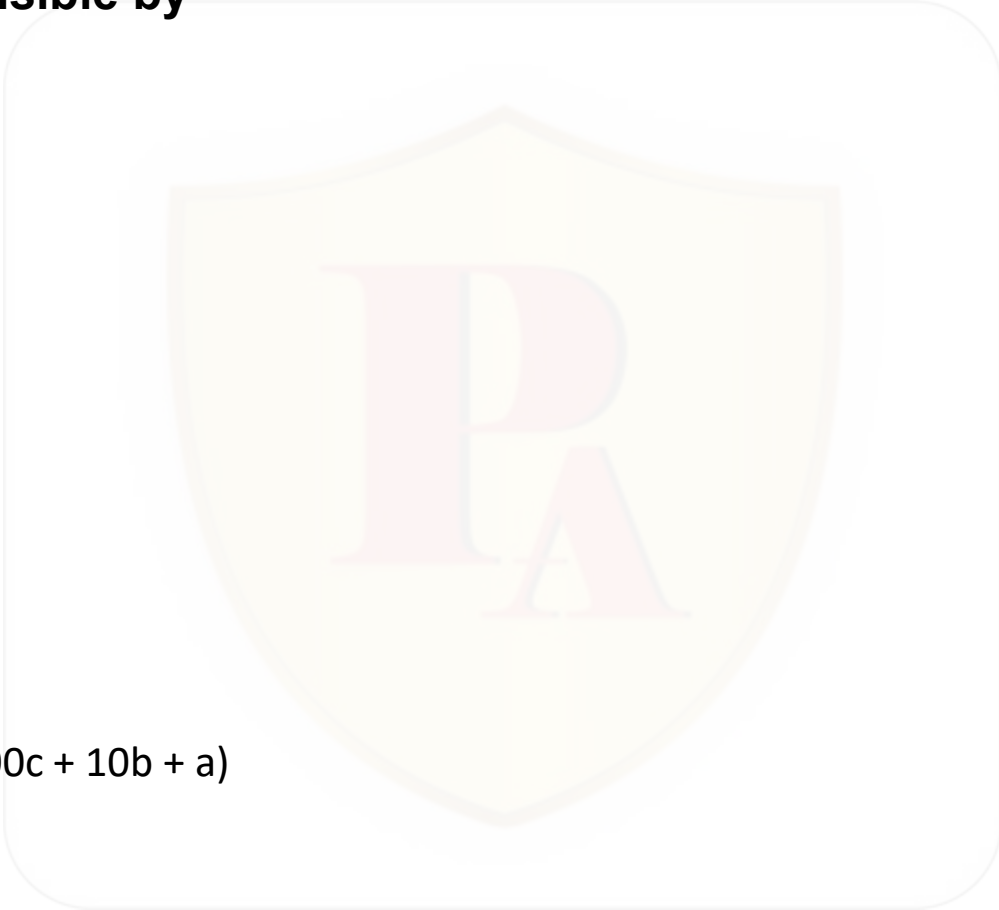From the conditions given : 2 males and 3 females

The difference between a three-digit number (with non-repeating digits) and the same number in the reverse order is always divisible by

1. 33

2. 22

3. 13

4. 31

Answer 1

Let the number be 100a + 10b + c

As per conditions (100a + 10b + c) – (100c + 10b + a)

= 99a – 99c

= 99 (a – c)

Divisible by 33

A car is moving along a bend in a road. The bend forms a large quarter circle. If the distance between the left and right wheels of the car is 2 m, then the difference between the distances travelled by the inner wheels and the outer wheels (in m) as it traverses the bend is

1. 0

2. 2

3. π

4. 2π

Answer 3

$r_{outer} = r_{inner} + 2m$

Distance travelled by inner and outer wheel is a quarter circle.

By outer wheel $= \dfrac{\pi r_{outer}}{4} = \dfrac{2\pi(r_{inner+2})}{4}$

By inner wheel $= \dfrac{2\pi r_{inner}}{4} = \dfrac{2\pi r_{inner}}{4}$

Difference in the distance travelled = outer − inner
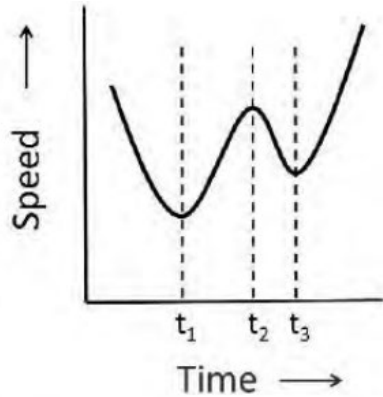
$= \dfrac{2\pi}{4}(r_{inner} + 2 - r_{inner})$

$= \pi$ m

The speed of a car travelling with variable acceleration along a straight line is shown in the figure.

If α_1, α_2, α_3 are the accelerations at times t_1, t_2, t_3, respectively, then

1. $\alpha_1 = \alpha_2 = \alpha_3$

2. $\alpha_1 > \alpha_3 > \alpha_2$

3. $\alpha_2 > \alpha_3 > \alpha_1$

4. $\alpha_3 > \alpha_2 > \alpha_1$

Answer 1

The slope of the graph between speed and time tells of the acceleration. At times t_1, t_2 and t_3 the slope is zero. Therefore, the acceleration at these points are equal.

The following graph shows the mortality risk of a disease with respect to parameters A and B.

Which of the following combinations of parameters is associated with the lowest mortality risk?

1. The lowest value of *A - B*

2. The lowest value of *B - A*

3. The lowest values of both *A* and *B*

4. The highest values of both *A* and *B*
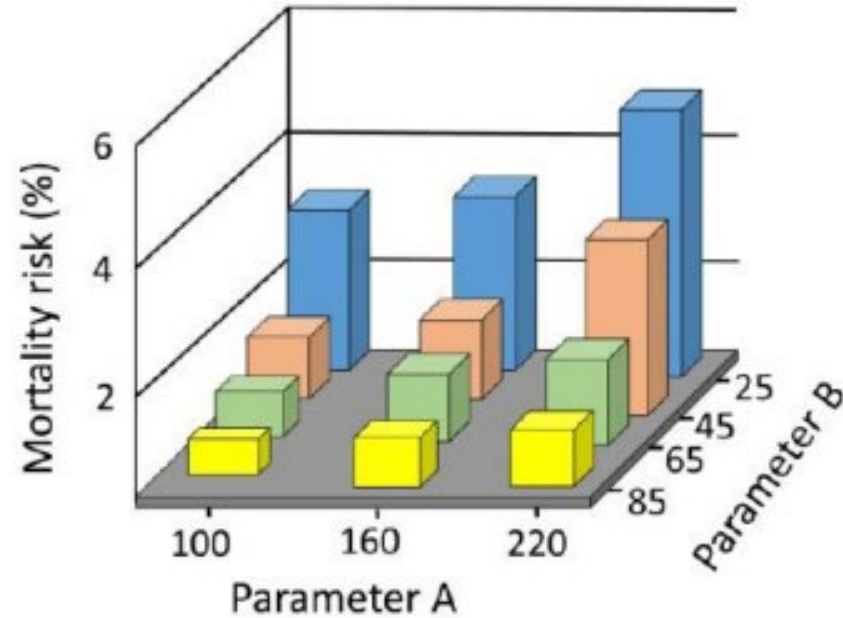
Answer 1

The left most, yellow colored bar is the lowest, with both parameter A and B values at their lowest.

The cost of 2 mangoes, 1 coconut and 2 bananas is Rs 71, while the cost of 5 mangoes, 3 coconuts and 4 bananas is Rs 182. What is the cost of 1 mango and 1 coconut?

1. It cannot be calculated

2. Rs 40

3. Rs 47

4. Rs 53

Answer 2

Let the cost of mangoes, coconut and banana is m, c and b per unit.

2m + 1c + 2b = 71 ...(i)

5m + 3c + 4b = 182 ...(ii)

Multiply equation (i) with 2 and subtract with equation (ii)

4m + 2c + 4b = 142

5m + 3c + 4b = 182

We have, – m – c = – 40

m + c = 40

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Three comparable brands of 1 litre cans of a liquid detergent are available in a shop with different offers as shown in the table.

Brand	List price (in Rs per can)	Offer
A	320	1/3rd extra
B	332	1 free for 3
C	300	20% discount

If 4 litres of detergent is to be purchased, then the best choice (based on unit price) would be

1.   **A or B**

2.   **A or C**

3.   **B or C**

4.   **B**

Answer 2

Cost of 4L of detergent;

A : Purchase of 3 can will fetch 1L extra

320 × 3 = ₹960/4L

B : Purchase of 3 cans will fetch 1L extra

332 × 3 = ₹996/4L

C : Purchase of 4 cans 300 × 4 = 1200

After discount = 1200 × 0.8 = ₹960

The largest integer between 1 and 10^5 when written in words that does not contain the letter 'N' or 'n' in its name is

1. 88

2. 100000

3. 88888

4. 8

Answer 1

88: Eighty-eight

100,000: One hundred thousand

88,888: Eighty-eight thousand eight hundred eighty-eight

8: Eight

Largest integer as per condition is 88.

Human females have two X chromosomes, each of which can be passed on to their son or daughter with equal probability. Human males have one X chromosome which is passed on to their daughters and one Y chromosome which is passed on to their sons. Assuming equal numbers of males and females in a population, if an X chromosome is randomly sampled from the population, what is the probability that it was inherited from a female of the previous generation?

1. 1/3

2. 1/4

3. 2/3

4. 3/4

Answer 3

The graph shows the distribution of lifespan (in years) for individuals from species 1 and species 2.

1. $\mu_1 > \mu_2$; $\sigma_1 > \sigma_2$

2. $\mu_1 = \mu_2$; $\sigma_1 = \sigma_2$

3. $\mu_1 = \mu_2$; $\sigma_1 > \sigma_2$

4. $\mu_1 = \mu_2$; $\sigma_1 < \sigma_2$

Answer 4

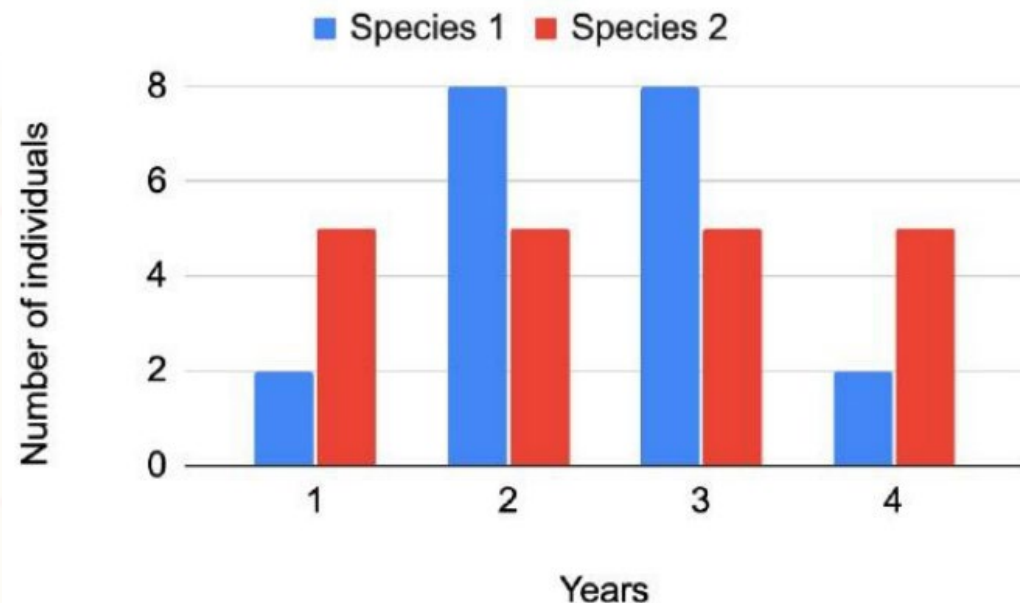$$u_1 = \frac{1 \times 2 + 2 \times 8 + 2 \times 8 + 4 \times 2}{(2+8+8+2)} = \frac{50}{20} = 2.5 \text{ years}$$

$$u_2 = \frac{1 \times 5 + 2 \times 5 + 3 \times 5 + 4 \times 5}{(5+5+5+5)} = \frac{50}{20} = 2.5 \text{ years}$$

Standard deviation

In case of species 1 middle numbers are high then externals low and highs which will lead to smaller σ, as compared to species 2 where all elements are equal.

Two rings made of metals A and B with ring A having a larger diameter, are placed concentrically leaving an annular gap. The thermal expansion coefficients of the two metals are C_A and C_B. Identify the correct statement(s) from the following.

A. The gap will decrease if $C_A < C_B$.

B. The gap will remain the same if $C_A = C_B$.

C. The gap will increase if $C_A < C_B$

1. Only A

2. A and B

3. Only C

4. B and C

Answer 1

The *thermal expansion coefficient* is a material property that quantifies how much a material's size changes with a change in temperature. Specifically, it measures the fractional change in length, area, or volume of a material per degree of temperature change. If the thermal expansion coefficient of B is greater than that of A, metal B will expand more than metal A when heated. Since ring B is inside ring A, the gap between them will decrease.

How many integers can divide 1184 leaving a remainder of 29?

1. 8

2. 5

3. 7

4. 9

Answer 4

So as to have a remainder of 29, subtract it from 1184 giving 1155. Now check for the factors of 1155.

The factors are 3, 5, 7, 11

Possible all combinations that will divide 1155 are:

3, 5, 7, 11, 3×5, 3×7, 3×11, 5×7, 5×11, 7×11, 3×5×7, 3×7×11, 5×7×11, 3×5×11, 3×5×7×11

Of them we will select those factors which are greater than 29. Those are:

3×11, 5×7, 5×11, 7×11, 3×5×7, 3×7×11, 5×7×11, 3×5×11, 3×5×7×11

There are total of 9 factors which will divide 1184 leaving a remainder of 29

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A pen, pencil and an eraser together cost Rs. 21. The pen costs as much more than the pencil as the pencil does than the eraser. How much does the pencil cost?

1. 5

2. 7

3. 9

4. 11
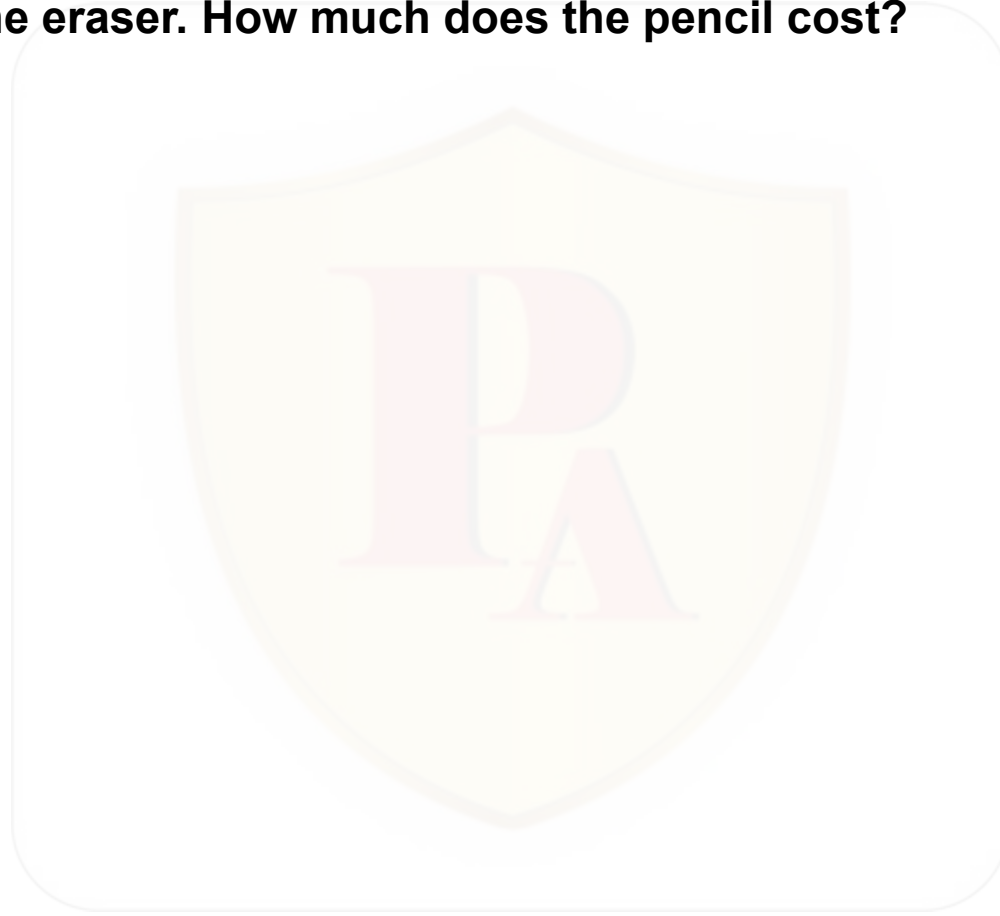
Answer 2

Let the cost of one eraser be e.

Cost of the pencil = e + x

Cost of the pen = e + 2x

1 pen + 1 pencil + eraser = 21

e + 2x + e + x + e = 21

3e + 3x = 21

e + x = 7

In a class, boys secure 69% marks on the average while girls secure 72% marks on the average. If the average marks of the entire class is 70% which of the following statements is valid?

1. The total number of students in the class is two times the number of girls.

2. The total number of students in the class is three times the number of boys.

3. The boys are two times the number of girls.

4. The girls are two times the number of boys.

Answer 3

Let the number of boys and girls be b and g, respectively.

Total number of marks scored by boys = 69b

Total number of marks scored by girls = 72g

Also, 69b + 72g = 70 (g + b)

b = 2g

i.e. boys are twice than girls.
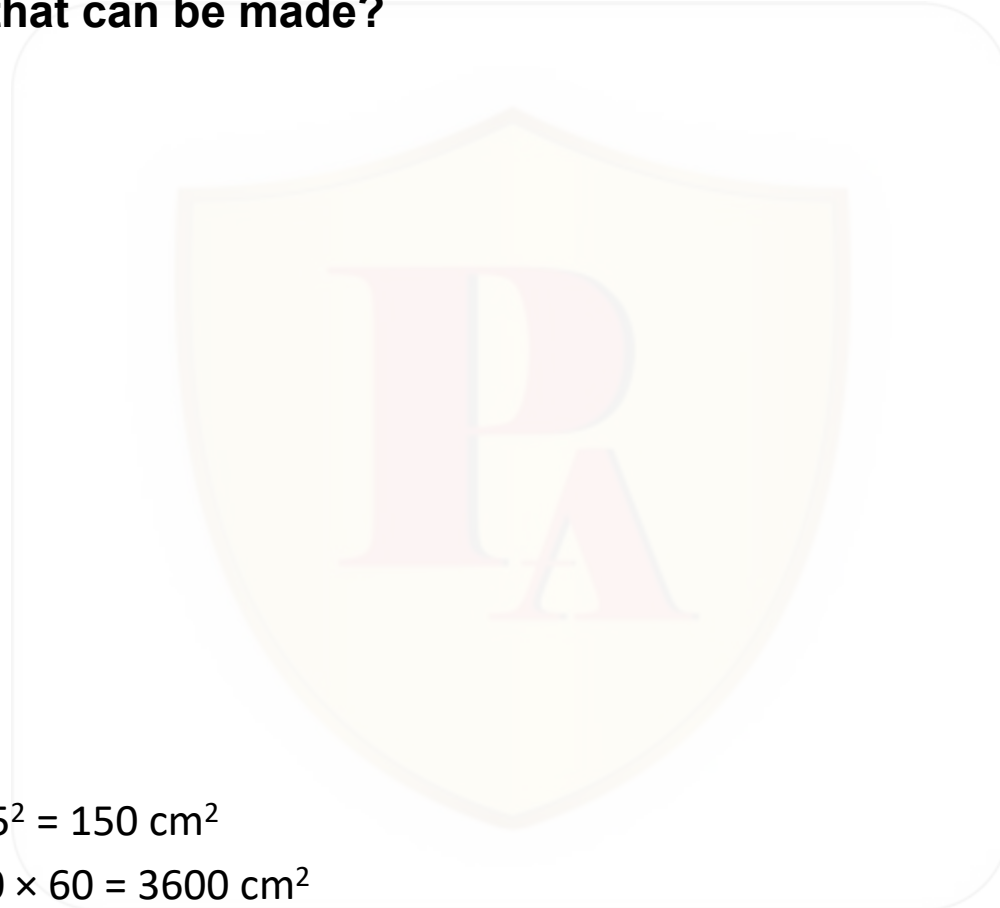
A cardboard sheet of size 60 cm × 60 cm is used to make hollow cubes having sides of 5 cm. What is the maximum number of cubes that can be made?

1. 24
2. 36
3. 72
4. 144

Answer 1

Total surface area of cube = $6a^2 = 6 \times 5^2 = 150$ cm^2

Total number of card board sheet = $60 \times 60 = 3600$ cm^2

Number of cubes = 3600/150 = 24

If Pencils are Erasers, some Erasers are Sharpeners, some Erasers are Crayons, no Crayons are Sharpeners but some Crayons are Pencils then in the given Venn diagram, which of the following is represented by the shaded area?

1. Pencils and Sharpeners but not Erasers and Crayons

2. Pencils and Erasers but not Sharpeners and Crayons

3. Pencils, Erasers, and Sharpeners but not Crayons

4. Pencils1 Erasers and Crayons but not Sharpeners
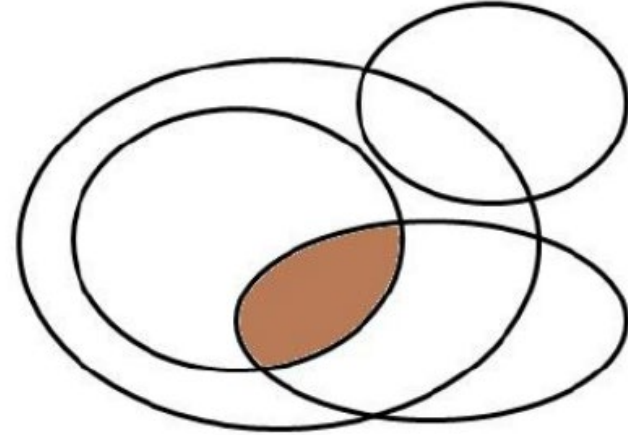
Answer 4
Observation based question.

A ball of moulding clay, whose radius is a , is remoulded into a cube. What is the approximate length of the side of the largest cube that can be so made?

1. 0.8♠

2. 1.2α

3. 1.6♠

4. 2α

Answer 3

Volume of sphere $= \frac{4}{3} \pi r^3 = \frac{4}{3} \pi a^3$

Volume of cube $= x^3$

Volume will be equal

$\frac{4}{3} \pi r^3 = x^3$

$x = \left(\frac{4}{3} \pi\right)^{\frac{1}{3}} a = 1.61 \, \alpha$

The following spider diagram shows the marks obtained (out of 10) by three students in five tests.

Which one of the following is INCORRECT?

1. A scored more than C in total

2. B scored the highest in total

3. A never scored 10 marks in a test

4. In Test 5, the combined marks of A and C are equal to the marks of B.
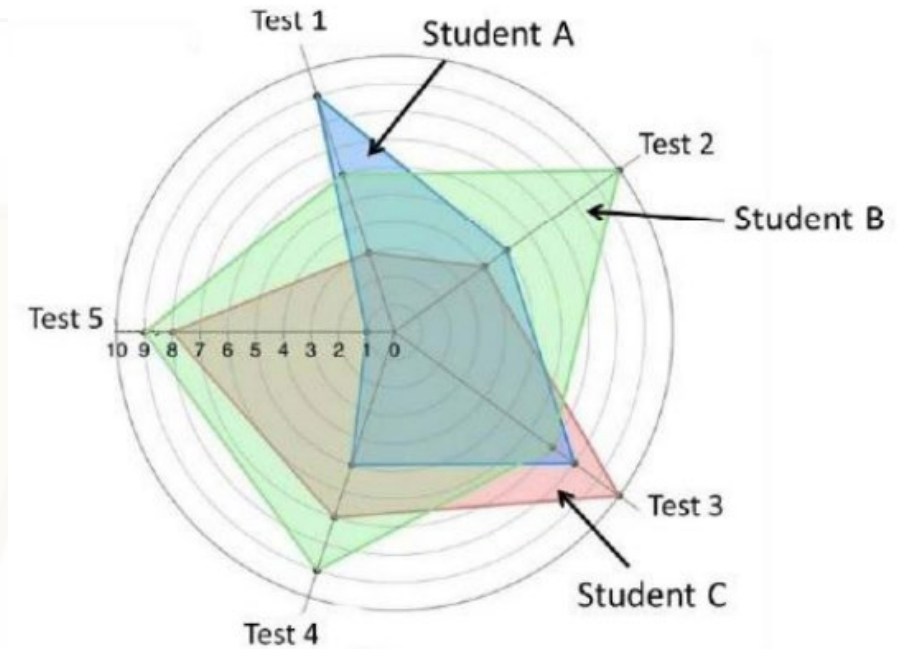
Answer 1

	T1	T2	T3	T4	T5	Total
A	9	5	8	5	1	28
B	6	10	7	9	9	41
C	3	4	10	7	8	32
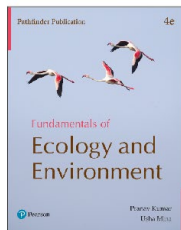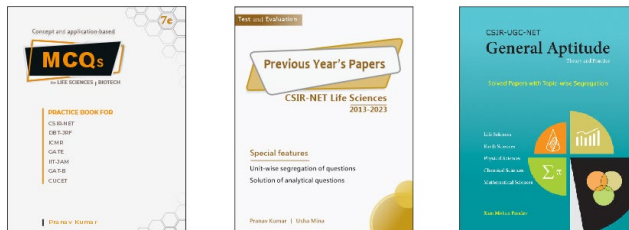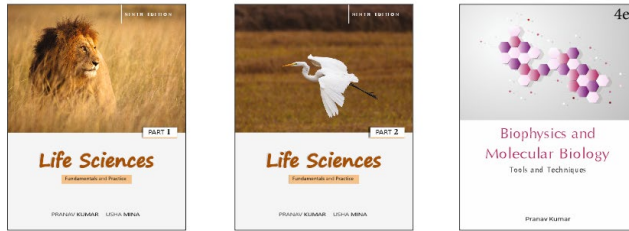
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PART - B

June 2024 Shift 2

Which one of the following is considered as a renal hormone?

1. **Megalin**

2. **Cubilin**

3. **Renalase**

4. **Uroguanylin**

Answer 3

Renalase is produced by the kidneys and acts as a hormone to regulate blood pressure and metabolism.

Which of following is a likely consequence of a loss of function mutation in the gene encoding the enzyme phenylalanine ammonia-lyase (PAL) in coffee plants?

1. **Increased levels of caffeine.**

2. **Decreased lignins in cell walls.**

3. **Increased lignins in cell walls.**

4. **Decreased levels of caffeine.**

Answer 2

PAL is involved in the phenylpropanoid pathway, which is essential for the biosynthesis of various secondary metabolites, including flavonoids, *lignins* and other aromatic compounds.

For detail you can consult **Fundamental and Practice, Life Sciences-2, 9th Edition**

https://pathfinderacademy.in/

Greenhouse Gas emissions are considered the primary driver of global warming through their influence on the radiative forcing of the atmosphere. This radiative forcing occurs because

1. **longwave radiation emitted by the earth's surface is absorbed and scattered.**

2. **shortwave radiation received from the sun is absorbed and scattered.**

3. **shortwave radiation emitted by the earth's surface is absorbed and scattered.**

4. **longwave radiation arriving from the sun is selectively transmitted.**

Answer 1

Radiative forcing refers to the difference between the amount of solar energy absorbed by the Earth and the energy radiated back to space. The Earth's surface, after absorbing shortwave solar radiation (mainly visible light) from the Sun, re-emits energy in the form of longwave radiation, which is primarily in the infrared part of the spectrum is *absorbed by greenhouse gases*.

For detail you can consult **Fundamental of Ecology and Environment, 4ᵗʰ edition**

In which one the following, the proton motive force generated in mitochondrial electron transport is NOT used?

1. **Transport of ATP into the cytosol from mitochondrial matrix.**

2. **Transport of ADP from the cytosol into the mitochondrial matrix.**

3. **Transport of phosphate ions from the cytosol into the mitochondrial matrix.**

4. **Transport of NADH from the cytosol into the mitochondrial matrix.**

Answer 4

The major function of oxidative phosphorylation is to generate ATP from ADP and P_i. Most of the ATP generated by oxidative phosphorylation in mitochondria is exported to the cytoplasm. Thus mitochondria must contain mechanisms to export ATP and import ADP and P_i. However, ATP and ADP do not diffuse freely across the inner mitochondrial membrane. A specific transport protein, **ATP-ADP translocase** (also called *adenine nucleotide translocase*), which acts as an antiporter, mediates the transport of ATP and ADP. ADP enters the mitochondrial matrix only if ATP exits, and vice versa. Because *ATP-ADP translocase* moves four negative charges out of every three moved in, its activity is favoured by the transmembrane electrochemical proton gradient, which gives the matrix a net negative charge. ATP-ADP translocase function is inhibited by a toxic glycoside **atractyloside**. ATP-ADP exchange is energetically expensive; transmembrane proton gradient across the inner mitochondrial membrane powers the exchange.

For detail you can consult **Fundamental and Practice, Life Sciences-1, 9th Edition**

https://pathfinderacademy.in/

In the thymus of a normal mouse, positive selection of T-cells is based on recognition of which of the following?

1. Foreign antigens in association with self-MHC molecules.

2. Self-antigens in association with foreign-MHC molecules.

3. Self-antigens in association with self-MHC molecules.

4. Foreign antigens in association with TLR ligands.

Answer 3

Thus, in positive selection double-positive T cell becomes *educated* to the MHC molecules expressed by the thymic cortical epithelial cells. This means that for the rest of the life of the T cell, even as a mature cell when it leaves the thymus, it will respond to antigen only when the antigen is bound to the MHC molecules that the developing T cell encountered in the thymus. For this reason, the MHC molecules expressed in a person's thymus and that educate his or her developing T cells are referred to as **self-MHC**; for that person, all other types of MHC molecules are **non-self**. This is the origin of the phenomenon known as **MHC restriction**, or more specifically, **self-MHC restriction**. *Hence, T cells recognize antigens in association with self MHC molecules but not in association with foreign MHC molecules.* The bulk of double-positive thymocyte death (~95%) occurs among thymocytes that fail positive selection because their receptors do not specifically recognize self-MHC molecules, a process known as **death by neglect**.

For detail you can consult **Fundamental and Practice, Life Sciences-1, 9th Edition**

The proponents of sustainable development argue for a switch to a predominantly plant-based diet, in order to reduce the human footprint of food production. The statements given below present some of the arguments put forward by them.

A. Animal-based diets involve greater thermodynamic energy loss.

B. The production of animal-based foods involves high carbon burn-off.

C. Animal tissues have high C:N ratios.

D. Animal tissues have high water content.

Select the option that constitutes the basis of their argument.

1. A and B

2. A and C

3. B and C

4. B and D

Answer 1

Statements A and B are correct. Animal-based diets involve greater thermodynamic energy loss due to inefficiencies in energy transfer through the food chain. The production of animal-based foods generally involves higher carbon emissions and environmental impacts compared to plant-based foods.

Ian Pavlov conducted experiments to demonstrate that a dog that associates the sound of a bell with food , would salivate on hearing the bell even when the food was not presented. This is an example of

1. **Operant conditioning.**

2. **Classical conditioning.**

3. **Sensitization.**

4. **Habituation.**

Answer 2

Ian Pavlov's experiments, where a dog learned to salivate at the sound of a bell even in the absence of food, are an example of *classical conditioning*.

Which one of the following organisms is NOT paedomorphic?

1. **Oikopleura**

2. **Branchiostoma**

3. **Ambystoma**

4. **Triturus**

Answer 2

Paedomorphic refers to a phenomenon in evolutionary biology where an organism retains juvenile or larval traits into adulthood.

Which one of the statements about bacterial operons is INCORRECT?

1. **Operons can encode multiple proteins with linked biological activity.**

2. **An operon expresses multiple proteins from a single mRNA.**

3. **mRNA transcript of an operon has only one Shine Dalgarno sequence upstream of the first ORF.**

4. **Operon expression is often tightly regulated.**

Answer 3

The Shine-Dalgarno sequence is a ribosomal binding site found in bacterial mRNA. It is essential for initiating translation by aligning the ribosome with the start codon of the mRNA. The mRNA transcript of an operon have multiple Shine-Dalgarno sequences, each associated with a different structural gene.

Which one of the following is most commonly used for barcoding-based identification of animal species?

1. **Cytochrome oxidase I**

2. **Microsatellites**

3. **28S**

4. **MatK**

Answer 1

Cytochrome oxidase I gene is the most widely used marker for DNA barcoding of animal species. It provides a highly informative and relatively simple means of identifying and distinguishing between different animal species due to its variability among species and conservation within species.

Which one of the following statements best describes an acrosomal reaction?

1. It is a repulsive interaction between the sperm and the egg.

2. It involves digestion of the acrosome by the sperm when it encounters an egg.

3. It leads to digestion of the zona pellucida.

4. It is the fusion of the sperm and egg plasma membranes.

Answer 3

Acrosomal reaction: The capacitated sperm undergo the acrosome reaction. On encountering an egg, a capacitated sperm must penetrate the egg's **zona pellucida**, a physical barrier between the oocyte and the follicular cells. The zona pellucida in mammals plays a role analogous to that of the vitelline envelope in invertebrates. The zona

For detail you can consult **Fundamental and Practice, Life Sciences-2, 9th Edition**

A *Drosophila* stock that is heterozygous null for a unique nuclear target gene was sib-mated. The target gene is essential for the development of *Drosophila*. The embryos from the cross were analyzed and the following results were obtained:

- PCR analysis of the genomic DNA isolated from embryos showed that 25% of the embryos did not have the target gene.

- Northern analysis of the RNA isolated from the above embryos showed the presence of transcript corresponding to the target gene.

- No lethality was observed in the progeny.

Which one of the following options can best explain the above observations?

1. Transcripts of the target gene are paternally contributed.
2. Transcripts of the target gene are maternally contributed.
3. The transcripts are observed due to mitochondrial inheritance.
4. The transcripts are being detected from yeast that larvae eat.

Answer 2

In *Drosophila*, maternal effect genes are genes whose products (like mRNA or proteins) are deposited in the egg by the mother and are essential for early embryonic development. The presence of target gene transcripts in the embryos, despite the embryos themselves lacking the gene, indicates that the mRNA from the target gene is maternally contributed.
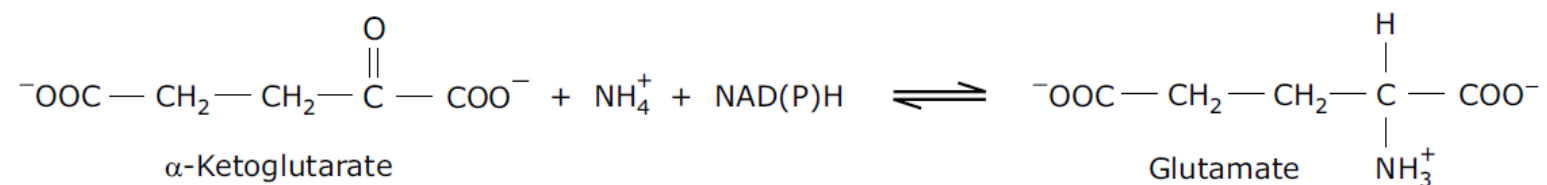
Which one of the following compounds can serve as a direct acceptor of an additional amino group derived from amino acid catabolism?

1. Fumarate

2. Glutamine

3. α-Ketoglutarate

4. Asparagine

Answer 3

Reductive amination of α-keto acids

Glutamate dehydrogenase catalyzes the reductive amination of α-ketoglutarate and forms glutamate. *This pathway is present in all organisms*. In eukaryotes, this is a minor pathway and occurs in the mitochondria. Glutamate dehydrogenase is an unusual enzyme in that it does not discriminate between NADH and NADPH.

$$^-OOC-CH_2-CH_2-\overset{\overset{O}{\|}}{C}-COO^- + NH_4^+ + NAD(P)H \rightleftharpoons {}^-OOC-CH_2-CH_2-\overset{\overset{H}{|}}{\underset{\underset{NH_3^+}{|}}{C}}-COO^-$$

α-Ketoglutarate   Glutamate

For detail you can consult **Fundamental and Practice, Life Sciences-1, 9th Edition**

https://pathfinderacademy.in/

The Burgess Shale in the Canadian Rocky Mountains is known for its Cambrian fossils. This site is abundant in which one of the following fossil assemblages?

1. Arthropods

2. Dinosaurs

3. Woody plants

4. Fishes

Answer 1

This question is information based.

Topoisomerase activity was measured in terms of change in the linking number of DNA in the presence of Camptothecin (inhibitor of Topoisomerase I) or Etoposide (inhibitor of Topoisomerase II). Which one of the following is the correct expected outcome?

1. In the presence of Camptothecin, Topoisomerase I will lead to change in the linking number by ±2.

2. In the presence of Etoposide, Topoisomerase I will lead to change in the linking number by ±2.

3. In the presence of Camptothecin, Topoisomerase II will lead to change in the linking number by ±2.

4. In the presence of Etoposide, Topoisomerase II will lead to change in the linking number by ±2.

Answer 3

Both type I and type II topoisomerases change the linking number of DNA. Type IA topoisomerases change the linking number by one and type IB topoisomerase change the linking number by any integer, while type IIA and type IIB topoisomerases change the linking number by two.

For detail you can consult **Fundamental and Practice, Life Sciences-2, 9ᵗʰ Edition**

Which of the following biogeographic realms are divided by the Wallace Line?

1. **Indomalaya and Neotropical**

2. **Indomalaya and Australasia**

3. **Nearctic and Palearctic**

4. **Palearctic and Afrotropical**

Answer 2
This question is information based.

Which one of the following statements regarding the invasion of blast fungus, *Magnaporlhe oryzae* in rice is INCORRECT?

1. A biotrophic interfacial complex is formed.

2. Fungal effector proteins are translocated into the host cell cytoplasm.

3. Appressorium is produced to invade the plant.

4. Haustorium is mostly formed to extract nutrients from the host.

Answer 4

The following graphs represent plots for the volume (dotted lines) and bacterial viable cell count curves (solid line) for a fermenter culture.
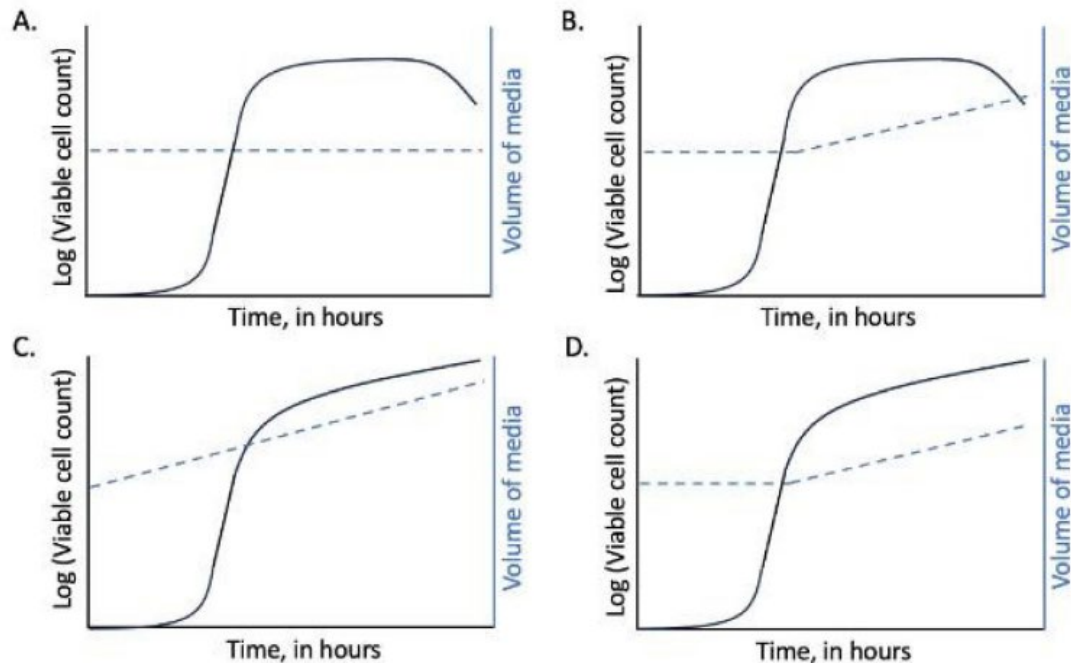
Which one of the following corresponds to the features applicable to a fedbatch mode of fermenter culture?

1. A

2. B

3. C

4. D

Answer 4

In fed batch culture, additional nutrients are added periodically or continuously during the culture to maintain optimal growth conditions and support high cell density or product yield.

The *trp* operon can be induced by the addition of indole propionic acid (IPA), which binds to the *trp* repressor but does not allow the change in conformation. Upon the addition of IPA, what will be the order of the translation of the enzymes encoded by the operon?

1. TrpA, TrpB, TrpC, TrpD, TrpE

2. TrpE, TrpD, TrpC, TrpB, TrpA

3. Only TrpE will be translated

4. Only TrpA will be translated

Answer 2
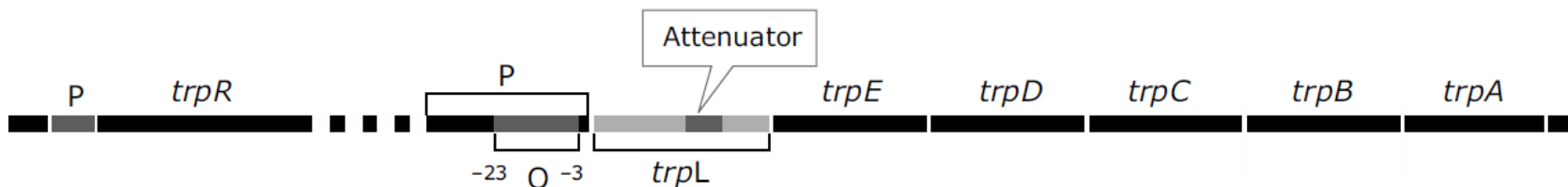
For detail you can consult **Fundamental and Practice, Life Sciences-2, 9ᵗʰ Edition**

Which one of the following properties of grooves is a hallmark of the Z-form of DNA?

1. **Narrow and deep major groove**

2. **Wide and deep major groove**

3. **Narrow and shallow major groove**

4. **Flat major groove**

Answer 4

Z-DNA is thinner (18 Å) than B-DNA (20 Å) and there is only one deep, narrow groove equivalent to the minor groove in B-DNA. No major groove exists. In contrast to B-DNA where a repeating unit is a 1 base pair, in Z-DNA the repeating unit is a 2 base pairs. This dinucleotide repeat causes the backbone to follow a zigzag path, giving

For detail you can consult **Fundamental and Practice, Life Sciences-1, 9th Edition**

The pedigree in Panel (i) represents the inheritance pattern of a given trait. The trait is NOT 100% penetrant. Panel (ii) represents PCR amplification profile of each member of the family using a specific primer pair. (M: mother, F: father, C: child)

What is the mode of inheritance of this trait?

1. Autosomal recessive

2. Autosomal dominant

3. X-linked recessive

4. X-linked dominant

(i) Family 1   Family 2   Family 3

(ii)
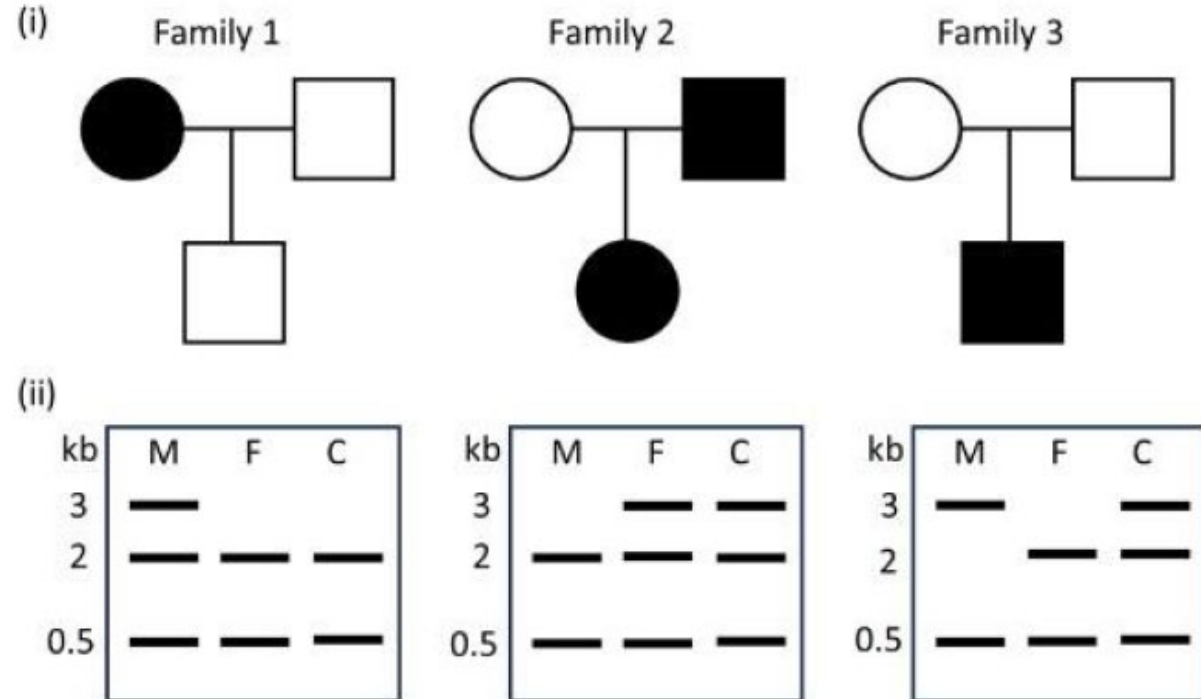
Answer 2

A 160 kDa complex of four protein molecules, consists of a dimer formed by a 25 kDa protein connected by two disulfide bonds, and three other proteins of 10, 30 and 70 kDa, respectively. It was isolated and analyzed on an SDS-PAGE gel without DTT in the gel loading dye. Which one of the following options would represent the SDS-PAGE profile?

1. Four bands corresponding to 10, 30, 50 and 70 kDa

2. Four bands corresponding to 10, 25, 30 and 70 kDa

3. One band corresponding to 160 kDa

4. Two bands corresponding to 50 kDa and 110 kDa

Answer 1

Dithiothreitol, DTT - a reducing agent. The 50 kDa band represents the dimer of the 25 kDa protein, and the 10, 30, and 70 kDa proteins will appear as separate bands.

Which one of the following is an example of parametric statistical test?

1. Kruskal Wallis test

2. Fisher's exact test

3. Unpaired t-test

4. Wilcoxon signed rank test

Answer 3

A parametric statistical test is a type of statistical test that makes certain assumptions about the parameters of the population distribution from which the sample is drawn. These assumptions usually involve the distribution being normal (or approximately normal) and having equal variances among groups.

Normal human fibroblasts, cancer cells (that originated in stem cells) and fibroblasts transduced with hTERT (hTERT cells) were passaged for 35 generations. Southern blot analysis was performed using DNA from above cells using radio-labelled probes for telomeric sequences. Which one of the following band patterns would be observed in the autoradiogram?

1. 7-9 kb bands in fibroblasts, 18-20 kb bands in cancer and hTERT cells.

2. 18-20 kb bands in fibroblasts, 7-9 kb bands in cancer and hTERT cells.

3. 7-9 kb bands in fibroblasts and hTERT cells, 18-20 kb bands in cancer cells.

4. 18-20 kb bands in fibroblasts and hTERT cells, 7-9 kb in cancer cells.

Answer 1

Senescence is defined as a phenomenon in which cells enter in a state of permanent irreversible cell cycle arrest. A variety of stresses such as oxidative damage, DNA damage can induce senescence. The first observation of cell senescence was reported by Hayflick and Moorhead. They observed that primary human fibroblast cells stop dividing after a certain number of division and described it as **replicative senescence**. It appears to be a fundamental feature of somatic cells, with the exception of most tumor cells and possibly certain stem cells. Normal eukaryotic cells have only a limited capacity for cell division. The number of mitotic divisions a cell is capable of undergoing in tissue culture before it stops dividing is described as the **Hayflick limit**. Telomere shortening is considered as the main causal mechanism of replicative senescence. The telomeres are short tandemly repetitive DNA sequences that cap

For detail you can consult **Fundamental and Practice, Life Sciences-1, 9th Edition**

Two students performed an ELISA to determine the amount of anti-Spike antibody in serum of a Covid-19 patient. They used the same ELISA plates, the same reagents for coating, blocking and detection, and the same ELISA reader. Both generated independent standard curves of absorbance vs concentration using the same Spike protein. Student 'A' correctly reported a concentration of 100 µg/ml, but student 'B' reported 450 µg/ml. Which one of the following could most likely explain the wrong result of student 'B'?

1. The ELISA plate was not washed properly between coating with antigen and blocking.
2. The ELISA plate was not washed properly after addition of sample.
3. The slope of the standard curve generated by student B was lower than optimal.
4. The negative control showed very little absorbance.

Answer 3

How many molecules of acetyl-CoA condense to produce isopentenyl diphosphate, the precursor for the formation of terpenoids by mevalonate pathway?

1. Two

2. Three

3. Four

4. Five

Answer 2 (However, the answer given by NTA is **3**)

Biosynthesis: There are two biosynthetic pathways for terpenes– MVA (**mevalonic acid**) pathway and MEP (**methylerythritol phosphate**) pathway. In an **MVA pathway**, acetyl-coenzyme A acts as a precursor. Three molecules of acetyl-CoA are joined together to form mevalonic acid. This key six-carbon molecule is then pyrophosphorylated, decarboxylated and dehydrated to yield isopentenyl pyrophosphate (IPP). IPP isomerizes to *dimethylallyl pyrophosphate*
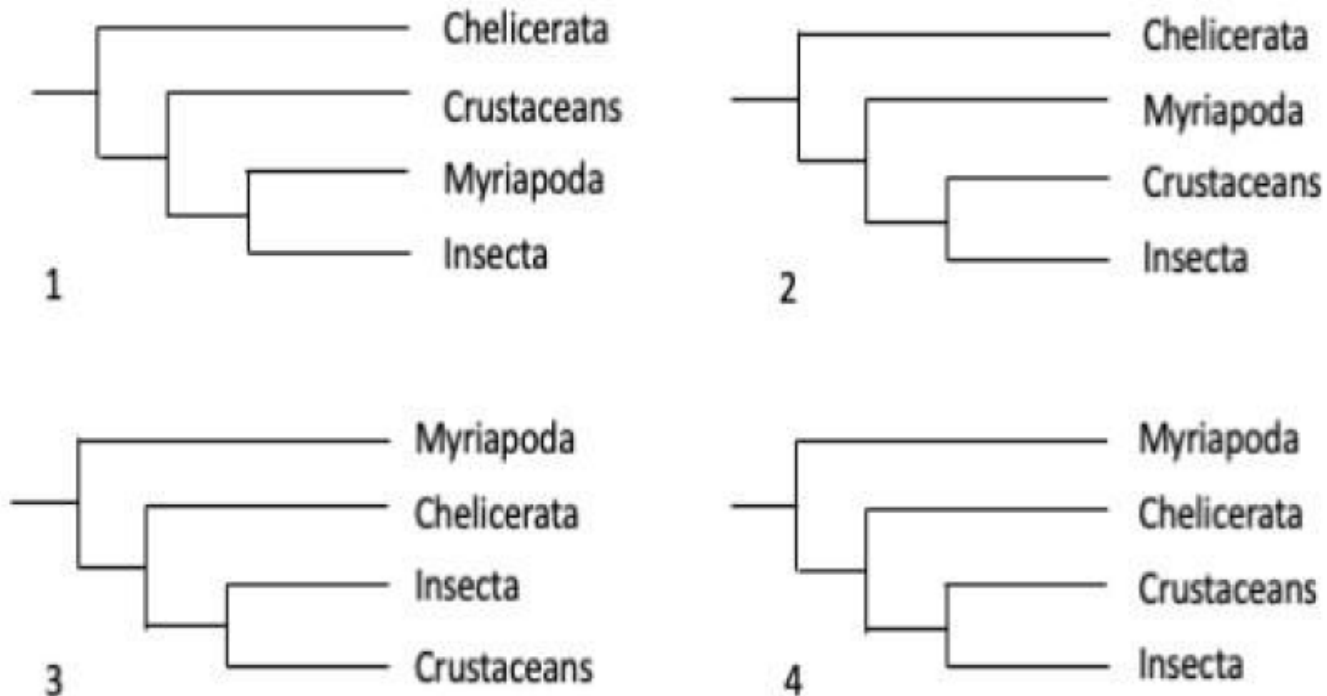
For detail you can consult **Fundamental and Practice, Life Sciences-2, 9th Edition**

Which one of the following molecular phylogenetic trees depicts the correct relationship among invertebrates?

Answer 2

Which one of the statements about homoplasy is NOT true?

1. It represents an independent acquisition of traits in unrelated lineages.

2. It refers to a character shared by a set of species but not present in their common ancestor.

3. It refers to a character state that evolved because of convergent evolution.

4. It represents characters that are similar due to parsimony.

Answer 4

homology (homologous character). A **homoplasy** is a character that species share through convergent evolution. It is a similarity in appearance but not in origin. The wings of birds and bats are an example of a homoplasious character.

The homoplasy shared between species that were not present in the common ancestor. These characters are not an indicator of phylogenetic relationship. Homoplasy also refers to **analogous structures** which is similarity in function but not in origin. A **homology** is a character shared between species that was also present in their common ancestor

For detail you can consult **Fundamental and Practice, Life Sciences-2, 9th Edition**

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Which one of the following statements regarding genetics of quantitative traits in plants is INCORRECT?

1. Loci responsible for a quantitative trait can show variations in their individual contributions to the trait.

2. Quantitative trait loci (QTL) always have identical effects on a phenotypic trait in different environments.

3. Recombinant Inbred Lines (RIL) populations used for OTL mapping are immortal.

4. $F_{2:3}$ families can measure both additive and dominant effects at specific QTL.

Answer 2

The effects of QTL on a phenotypic trait can vary depending on the environment. This interaction between genotype and environment means that the influence of a QTL may not be constant across different environmental conditions. Different environments can alter the expression of genes associated with QTL. For instance, a QTL that affects plant height might have a stronger effect in one soil type compared to another.

Which one of the following is the strongest oxidizing agent produced during photosynthesis?

1. **NADPH**
2. **P680$^+$**
3. **Ferredoxin**
4. **P700$^+$**

Answer 2

The positively charged P680$^+$, *a strong oxidizing agent*, attracts an electron from an electron donor to regenerate the original P680. In oxygenic photosynthetic organisms, H_2O acts as an electron donor. Splitting of two water molecules yields four electrons, four protons and molecular oxygen.

For detail you can consult **Fundamental and Practice, Life Sciences-1, 9th Edition**

The term gynodioecious species refers to plants with

1. female flowers and hermaphrodite flowers on separate individuals.

2. female flowers and male flowers on separate individuals.

3. female flowers and hermaphrodite flowers on the same individual.

4. female flowers and male flowers on the same individual.

Answer 1

A *gynodioecious species* is a plant species that has two types of individuals: one with only female flowers (gynoecious) and another with both male and female flowers (androgynous or hermaphroditic).

The Ti plasmid from *Agrobacterium tumefaciens* has genes for auxin, cytokinin and opine synthesis while genes for opine catabolism and Vir genes lie outside the T-DNA region. Which one of the following genes are involved in providing carbon source to *Agrobacterium* in their ecological niche?

1. Genes for auxin synthesis only.

2. Genes for auxin as well as cytokinin synthesis.

3. Genes for opine synthesis and opine catabolism.

4. Genes for auxin synthesis as well as opine synthesis.

Answer 3

T-DNA carries genes for **phytohormones** (auxin and cytokinin) and **opines** that are expressed in plant cells. The overproduction of phytohormones at the site of infection is responsible for the proliferation of wound cells into a gall (tumor) that can harbour a population of the bacteria. Opines are of different types: **nopaline**, **octopine** and **agropine**. Ti plasmid can be divided into different groups, according to the types of opine that are made: *nopaline plasmids*, *octopine plasmids* and *agropine plasmids*. These opines are condensation products of either an amino acid and a keto acid or an amino acid and a sugar. The opines are used as a carbon and nitrogen source and are catabolized by *Agrobacterium*.

For detail you can consult **Fundamental and Practice, Life Sciences-2, 9th Edition**

https://pathfinderacademy.in/
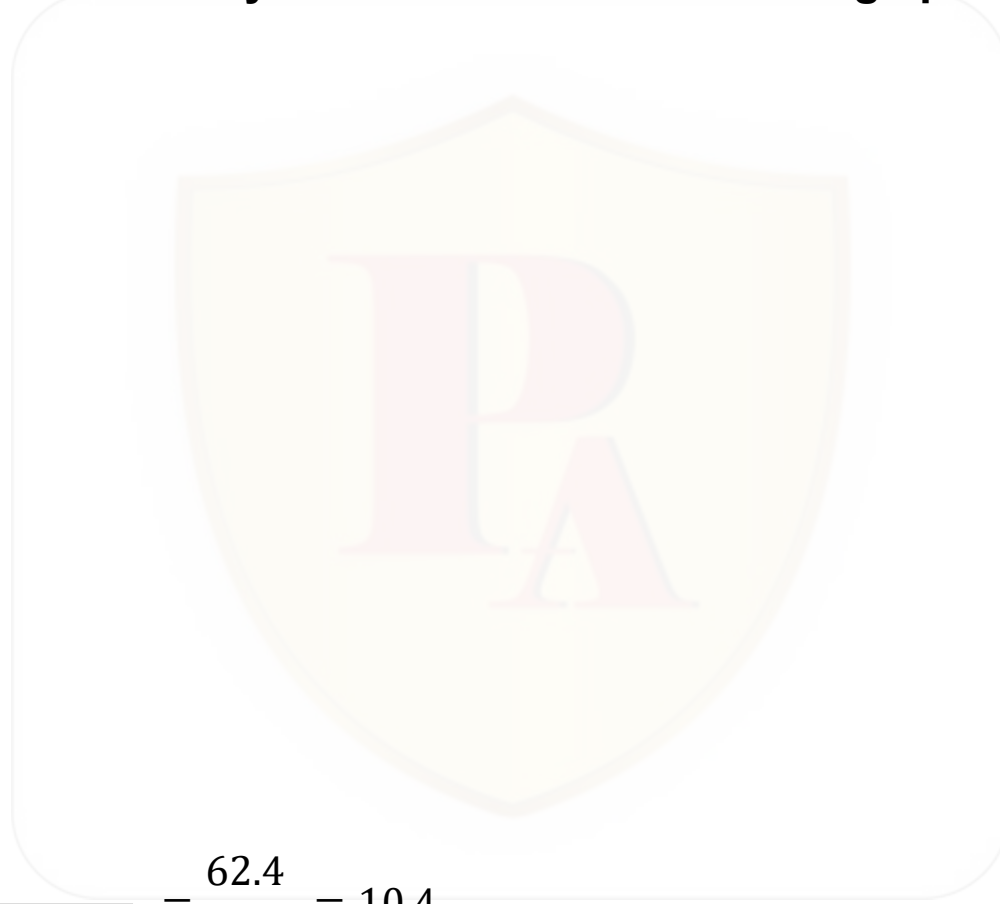
The pH of water in Lonar lake was found to be 10.5, 10.3, 10.1, 10.4, 10.7, and 10.4 for measurements taken once daily over six days. What would be the average pH of the lake water during this period?

1. 10.56

2. 10.26

3. 10.36

4. 10.46

Answer 3

$$Average\ pH\ = \frac{SUM\ of\ pH}{Number\ of\ measurements} = \frac{62.4}{6} = 10.4$$

Which one of the following statements regarding the stereoisomers of D-glucose is INCORRECT?

1. **D-mannose is a C-2 epimer of glucose.**

2. **D-allose is a C-3 epimer of glucose.**

3. **D-galactose is a C-4 epimer of glucose.**

4. **D-talose is a C-5 epimer of glucose.**

Answer 4

Which one of the following is NOT an example of programmed cell death in plants?

1. **Aerenchyma formation in cortical root cells**

2. **Embryonic suspensor cell degeneration**

3. **Tracheary element formation in vasculature**

4. **Casparian strip formation in root endodermis**

Answer 4

The Casparian strip is located in the endodermis, a layer of cells that is found between the cortex and the vascular tissue in plant roots. It is composed of suberin (a waxy substance) and sometimes lignin. These substances make the Casparian strip impermeable to water and solutes. It acts as a selective barrier that prevents the uncontrolled flow of water and dissolved substances between the cells of the endodermis.

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Runaway selection was proposed by R. A. Fisher to explain the evolution of extravagant secondary sexual characters. The model is based on the exaggeration of characters in male, and female choice for these exaggerated characters. Which one of the following statements is considered an assumption of this model?

1. Exaggeration of characters in males, and female choosiness for exaggeration are both heritable.

2. Neither exaggeration of characters in males, nor female choosiness for exaggeration are heritable.

3. Exaggeration of characters in males is heritable but female choosiness for exaggeration is not heritable.

4. Exaggeration of characters in males is not heritable but female choosiness for exaggeration is heritable.

Answer 1

Runaway selection theory: Female prefer traits that is sexually attractive so that offspring inherit the trait that makes them sexually attractive.

For detail you can consult **Fundamental and Practice, Life Sciences-1, 9th Edition**

https://pathfinderacademy.in/

Which one of the following statements is INCORRECT?

1. **Phage Mu is used to create insertion mutations.**

2. **Phage P1 is a source of Cre-LoxP recombination system.**

3. **Phage M13 has single-stranded circular RNA genome.**

4. **Phage ΦX17 4 has single-stranded circular DNA genome.**

Answer 3

M13 phage based vector for cloning DNA is especially useful for sequencing of the inserted DNA. This filamentous virus contains 6.4 kb single-stranded circular DNA. M13 enters *E. coli* through the bacterial sex pilus, a protein appendage that permits the transfer of DNA between bacteria. The single-stranded DNA in the virus particle [called the (+) strand] is replicated through an intermediate circular double-stranded **replicative form** (RF) containing (+) and (−) strands. Only the (+) strand is packaged into new virus particles.

For detail you can consult **Fundamental and Practice, Life Sciences-2, 9ᵗʰ Edition**

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Mutations in a specific mammalian signaling pathway result in early defects observed in the establishment or maintenance of midline structures, such as the notochord and the floor plate. Later defects include the absence of distal limb structures, ventral cell types within the neural tube, spinal column and most of the ribs and cyclopia. Mutations in which one of the following signaling pathways is the most reported cause for these congenital defects?

1. **Sonic Hedgehog**
2. **Wingless**
3. **Notch**
4. **Epidermal Growth Factor**

Answer 1

Mitotic cyclin increases gradually through the G2 phase of the cell cycle but the activity of mitotic CDK1 increases suddenly at the onset of M phase. This is because

1. active CDK1 subunit is synthesized in M phase.

2. mitotic cyclin is sequestered in the cytosol.

3. activation of CDK1 requires post-translational modifications.

4. the inhibitor of CDK1 is degraded in the M phase.

Answer 3

The gradual increase in mitotic cyclin levels during G2 prepares the cell for mitosis, while the sudden activation of CDK1 at the onset of M phase is a result of precise post-translational modifications that include the removal of inhibitory phosphates. This mechanism ensures that the cell enters mitosis at the right time and with the correct regulatory signals.

Natural selection can maintain genetic polymorphisms. Which one of the following CAN NOT contribute to the maintenance of polymorphisms?

1. **When the direction of selective forces is different in different environments**

2. **When heterozygotes have superior fitness over homozygotes**

3. **When gradients of selective forces favour different morphs**

4. **When frequency-dependent selection confers an advantage to a morph which is common.**

Answer 4

In *frequency-dependent selection*, the fitness of a morph depends on its frequency relative to other morphs in the population. However, if common morphs have an advantage, this typically leads to the fixation of that morph and a reduction in genetic polymorphism, rather than maintaining it.

Which one of the following statements is correct with respect to 95% confidence interval of the estimated mean from a set of observations?

1. They are limits between which, in the long run, 95% of observations fall.

2. They are a way of measuring the precision of the estimate of the mean.

3. They are limits within which, the sample mean falls with probability 0.95.

4. They are a way of measuring the variability of a set of observations.

Answer 2

A yeast strain has accumulated a mutation that makes it grow slowly. Investigation reveals that ribosomal RNA levels have dropped drastically in this strain. Which RNA polymerase is likely to be mutated in this strain?

1. RNA Pol I
2. RNA Pol II
3. RNA Pol III
4. RNA Pol IV

Answer 1

Nuclear RNA polymerase

A single RNA polymerase is responsible for transcription of all different types of RNAs in prokaryotes. However, eukaryotes have five different types of RNA polymerases – RNA pol I, RNA pol II, RNA pol III, RNA pol IV and RNA pol V. **RNA pol I** is responsible for synthesizing most of the rRNA, **RNA pol II** synthesizes mRNA and most of the snRNA and **RNA pol III** synthesizes a variety of small RNAs including tRNA, 5S rRNA and U6 snRNA. All eukaryotic RNA polymerases

Which one of the following adrenoceptors decreases cAMP in the post-synaptic target after stimulation with norepinephrine?

1. α_1

2. α_2

3. β_1

4. β_2
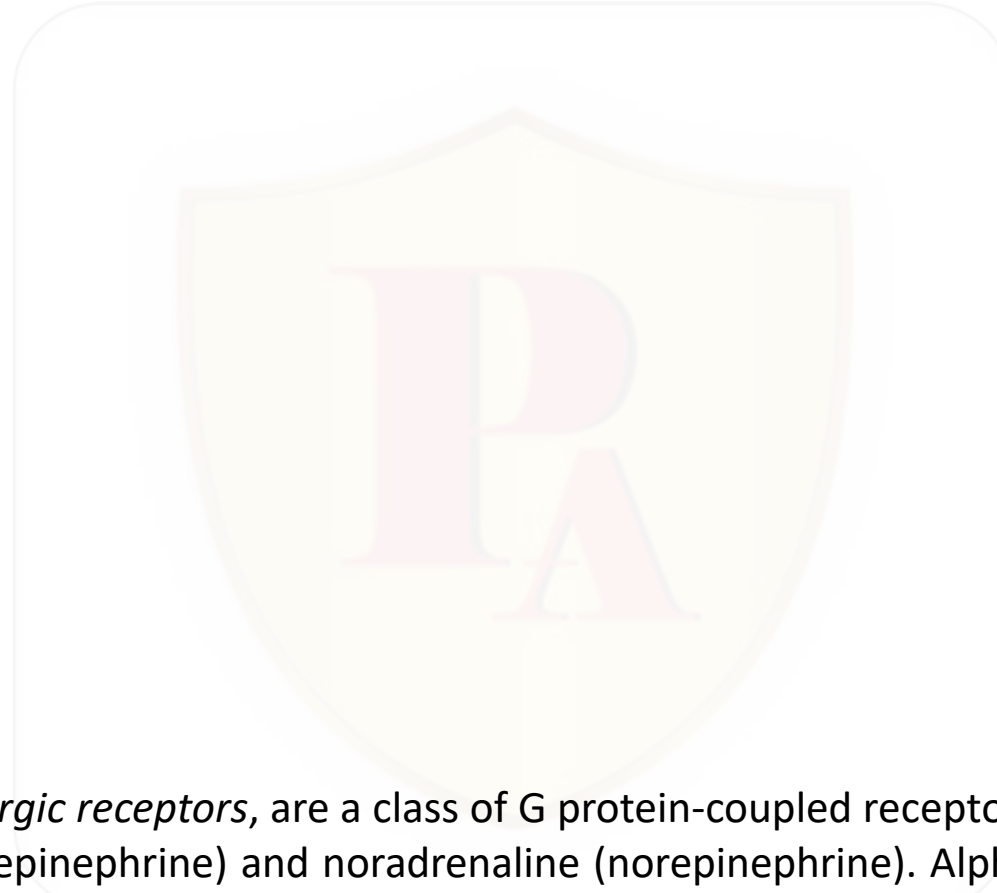
Answer 2

Adrenoceptors, also known as *adrenergic receptors*, are a class of G protein-coupled receptors (GPCRs) that respond to catecholamines, such as adrenaline (epinephrine) and noradrenaline (norepinephrine). Alpha-2 receptors (Coupled to Gi) are found in the central nervous system (CNS), presynaptic nerve terminals, and various peripheral tissues and typically inhibit neurotransmitter release.

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Which one of the following hormones is NOT exclusively synthesized from a single location in the body?

1. **Thyrotropin releasing hormone**

2. **Corticotropin releasing hormone**

3. **Somatostatin**

4. **Somatotropin**

Answer 3

Somatostatin is the hormone that is *not* exclusively synthesized from a single location, as it is produced in multiple tissues throughout the body, including the hypothalamus, pancreas, and gastrointestinal tract.

Loss of function mutations in snapdragon (*Antirrhinum*) genes *CYCLOIDEA* (*CYC*) and D*ICHOTOMA* (*DICH*) will result in the

1. conversion of bilaterally symmetric flower to a radially symmetric flower.

2. conversion of radially symmetric flower to a bilaterally symmetric flower.

3. conversion of bisexual flower to a male flower.
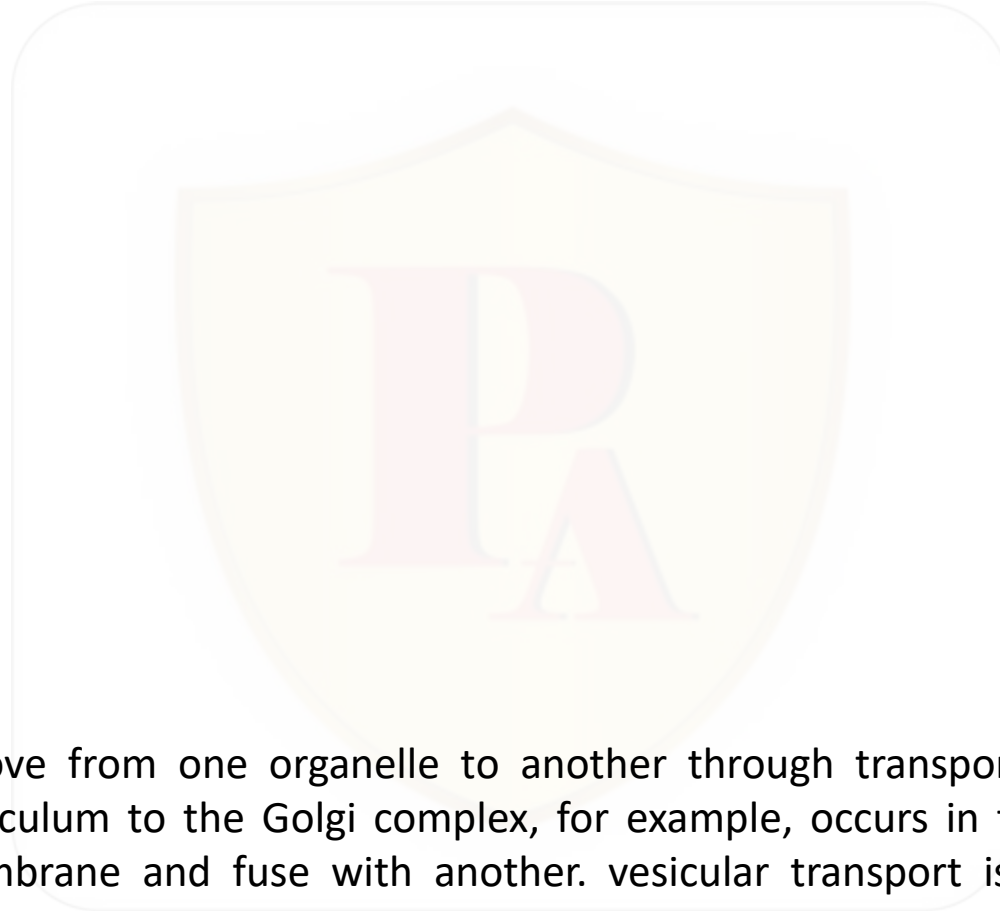
4. conversion of bisexual flower to a female flower.
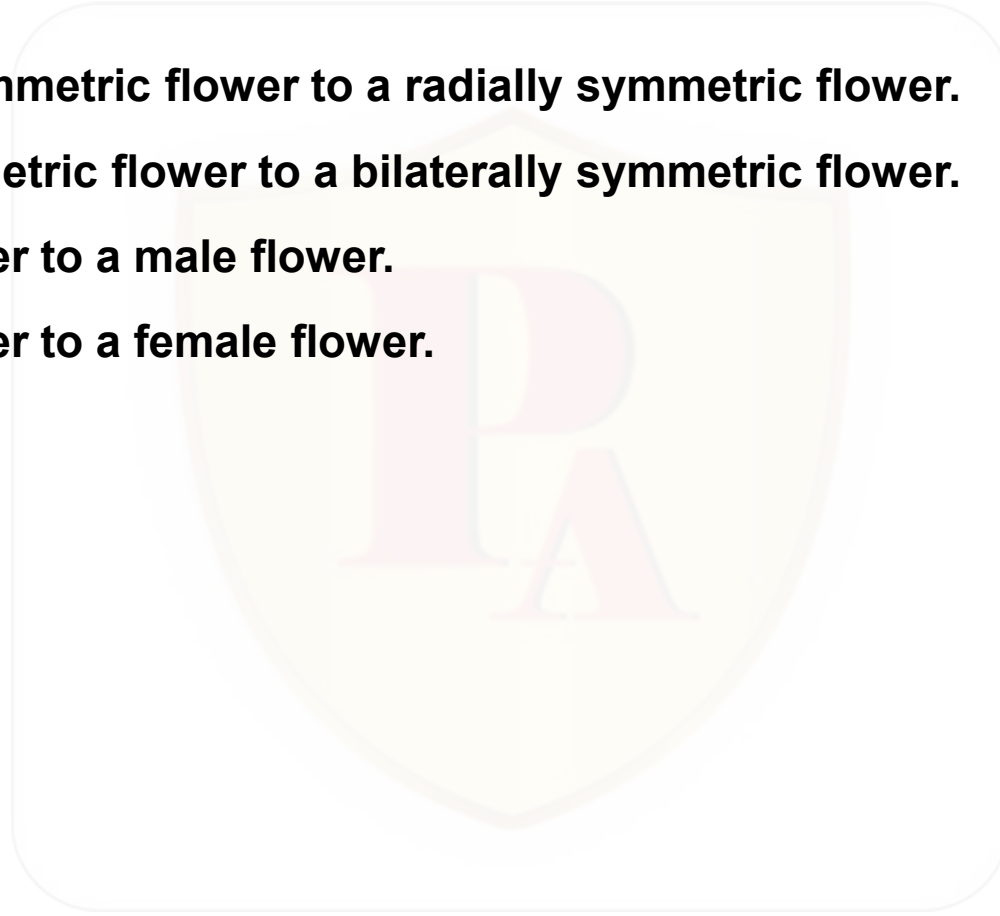
Answer 1

Among the organelles listed below, which one does NOT obtain proteins via vesicular transport?

1. **Endosomes**

2. **Lysosome**

3. **Mitochondria**

4. **Golgi**

Answer 3

In vesicular transport, proteins move from one organelle to another through transport vesicles. The transfer of proteins from the endoplasmic reticulum to the Golgi complex, for example, occurs in this way. Transport vesicles continually bud off from one membrane and fuse with another. vesicular transport is possible only among the members of endomembrane system.

For detail you can consult **Fundamental and Practice, Life Sciences-1, 9th Edition**

The immune recognition of "self-molecules" is important for which of the following events?

1. Initiation of B cell activation leading to antibody production.

2. Promoting the differentiation of hematopoietic stem cells.

3. Recombination of the T cell receptor.

4. Activation of natural killer (NK) cells of the innate immune system.

Answer 1 (However, the answer given by NTA is **4**)

Which one of the following gases diffuses through alveolocapillary membrane in shortest time at the resting condition?

1. CO

2. O_2

3. CO_2

4. N_2O

Answer 4

When *E. coli* and macrophages are placed in a petri dish with medium, the macrophages internalize the *E. coli* into cytoplasmic vesicles called phagosomes, which then fuse with lysosomes where the bacteria are killed. If *E. coli* is replaced by *M. tuberculosis* in the petri dish, which ONE of the following options will happen after attachment of the bacteria?

1.   The bacteria will be internalized by pinocytosis.

2.   The bacteria will be internalized by autophagy.

3.   The bacteria will prevent the maturation of phagosomes.

4.   The bacteria will prevent the generation of lysosomes in macrophages.

Answer 3

For example, following phagocytosis, bacterium *Listeria monocytogenes* secretes a protein called **listeriolysin O**, which disrupts the phagosomal membrane, releasing the bacteria into the cytosol. Similarly, *Mycobacterium tuberculosis* has evolved a unique life-style. After uptake by macrophages, *M. tuberculosis* arrests phagosome maturation and their fusion with lysosomes.
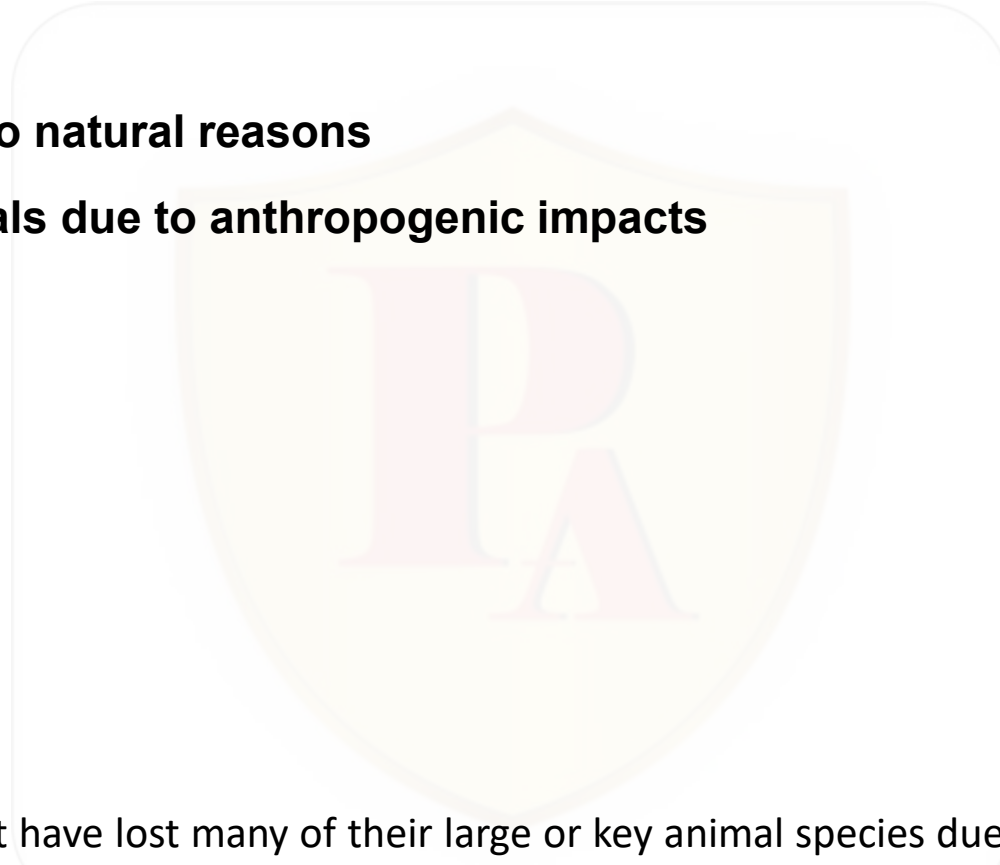
For detail you can consult **Fundamental and Practice, Life Sciences-1, 9th Edition**
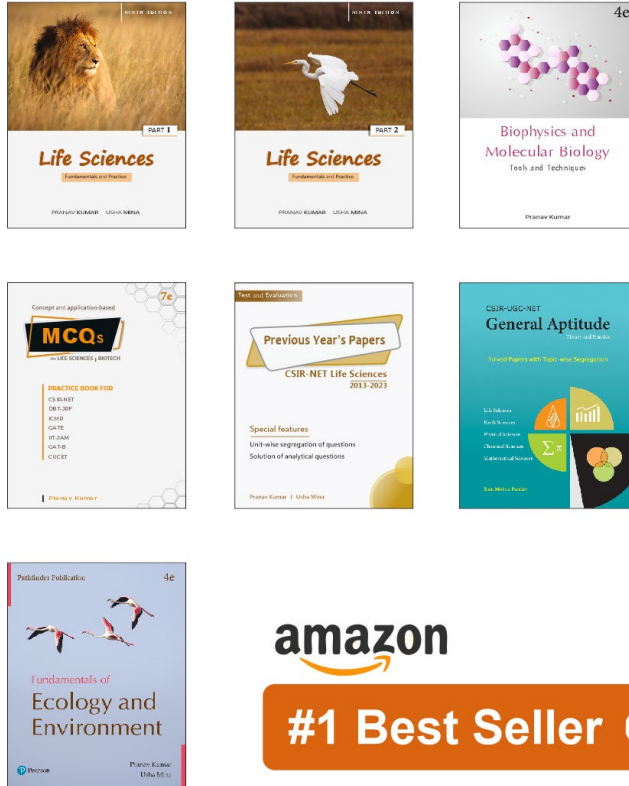
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Which of the following describes 'Empty Forest'?

1.   **Absence of large trees**

2.   **Less species diversity due to natural reasons**

3.   **Habitat void of large mammals due to anthropogenic impacts**

4.   **Loss of habitat**

Answer 3

The term typically refers to forests that have lost many of their large or key animal species due to factors such as hunting, habitat destruction, or ecological changes. In many tropical forests, the overhunting of large animals has led to situations where the forest still appears lush and green but lacks the complex interactions and species diversity that once characterized it.

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PART - C

June 2024 Shift 2

The statements given below indicate key characteristics of a geographical region.

A. Contains at least 1500 species of endemic animals

B. Contains at least 1500 species of endemic vascular plants

C. Has lost 70% of its original natural vegetation

D. Has lost 30% of its original natural vegetation

Which one of the following combinations represents the correct criteria for declaring an area as a biodiversity hotspot?

1. A and C

2. B and C

3. A and D

4. B and D

Answer 2

The concept of biodiversity hotspots originated with British ecologist and writer Norman Myers in 1988. A biodiversity hotspot is a relatively small area with an exceptional concentration of endemic species and a large number of endangered and threatened species. To qualify as a hotspot, a region must meet two strict criteria: it must contain at least 1,500 species of vascular plants (>0.5 percent of the world's total) as endemics, and it has to have lost at least 70 percent of its original habitat. Thus, hotspots are areas with the richest and most threatened reservoirs of plants and animals life on Earth. Norman Myers developed the hotspot concept to designate priority areas for *in-situ* conservation. A key criteria for determining a hotspot are:

For detail you can consult **Fundamental of Ecology and Environment, 4th edition**

https://pathfinderacademy.in/

According to ABCDE model of flower development, different combinations of MADS box proteins belonging to class A, B, C, D and E bind to each other to form a tetrameric structure referred to as "floral quartet" as given below. The floral quartet bind to DNA to activate transcription of the genes needed to specify each floral organ types.

AP1 = APETALA 1,　　　AP3 = APETALA 3,　　　PI= PISTILLATA,　　　AG= AGAMOUS

STK = SEEDSTICK,　　　SHP = SHATTERPROOF,　　　SEP= SEPALLATA 1/2/3

A.

AP1　AP1

SEP　SEP

B.

AP1　AP3

SEP　PI

C.

AP3　AG

PI　SEP

D.

SHP　STK

AG　SEP

E.

AG　AG

SEP　SEP
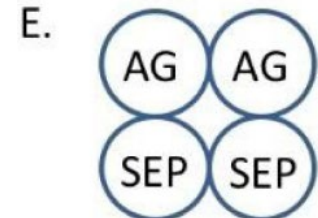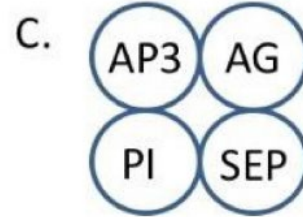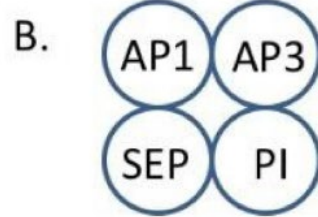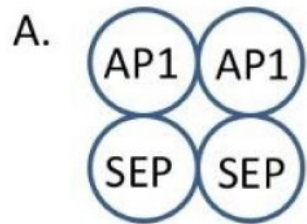
Which one of the following options represents the combination of floral quartets that specify petals and carpel whorl of flower, respectively?

1.　B and E

2.　C and D

3.　A and B

4.　D and E

Answer 1

The following statements are made about how CD4 T cells provide help to CD8 T cells.

A. Antigen/MHC-11 complexes on CD4 T cells interact with antigen/MHC-I complexes on CD8 cells.

B. A single dendritic cell (DC) presents antigen on MHC-I and MHC-11 at the same time.

C. CD4 T cells activate DCs which produce chemokines like CCL3 and CCL4 that can specifically attract CD8 T cells to form a CD4-CD8-DC triad.

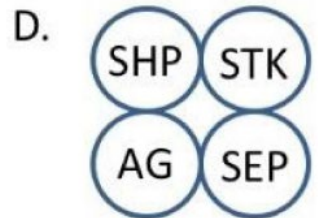D. CD4 T cells help B cells, which differentiate into plasma cells and secrete antibodies that form immune complexes which bind to FcγRs on CD8 T cells.

Which one of the following options represents the combination of all *correct* statements?

1. A and B
2. A and C
3. B and C
4. C and D

Answer 3

Dendritic cells are indeed capable of presenting antigens on both MHC Class I and MHC Class II molecules. **MHC-I** presents endogenous antigens (typically from cytosolic proteins) to CD8$^+$ T cells and M**HC-II** presents exogenous antigens to CD4$^+$ T cells. CD4$^+$ T cells can activate DCs and DCs can produce chemokines to attract CD8$^+$ T cells.

The cadherin catenin complex is extremely important during compaction from a morula to the blastula. Transition of early embryonic cells into a blastula differed depending on the presence or absence of calcium ions. In addition, an investigator blocked the expression of β-catenin using vivo morpholinos to detect its effect simultaneously on compaction. Which one of the following conditions will lead to the most successful transition of the morula into the blastula?

1. The blastula will continue to develop even when calcium ions are absent, since β-catenin will get activated automatically by cadherins.

2. In the absence of calcium ions, calcium ionophores will assist development even when vivo morpholinos to β-catenin are introduced.

3. Presence of calcium ions will enhance development when vivo morpholinos to cadherins have been introduced to the early embryo.

4. Presence of calcium ions are essential for activation of cadherin and β-catenin, so that actin gets mobilized and compaction ensues.

Answer 1

A DNA sequence is given below:

5' - ATGACGATGACGAGACGATGCAGATGATAGCAGTAGCGAATGAC - 3'

The following primers were designed to amplify the above sequence:

A. 5' - TACTGCT - 3'

B. 5' - CAGTAAG - 3'

C. 5' - ATGACGA - 3'

D. 5' - GTCATTC - 3'

E. 5' - TCGTCAT - 3'

F. 5' - GAATGAC - 3'

If we negate the effects of primer length, Tm, %GC and other factors, which one of the following options represents a combination of primers that could amplify the above DNA sequence?

1. A and C　　　　　2. B and D　　　　　3. E and F　　　　　4. C and D

Answer 4

Different phases of a typical nerve fibre action potential are explained in the following statements:

A. The membrane potential is brought to the threshold potential (firing level) due to the opening of some voltage-gated sodium channels in response to a threshold depolarizing stimulus.

B. The rapid depolarization after the firing level is caused by opening of more voltage-gated sodium channels and entry of Na^+ into the nerve fibre.

C. The reversal of membrane potential (overshoot) at the peak of action potential occurs as membrane potential moves towards the equilibrium potential of K^+.

D. The peak voltage of action potential does not reach the equilibrium potential of K^+ primarily because the increase of K^+ conductance is short-lived.

Which one of the following options represents the combination of the *correct* statements?

1. A and B
2. B and C
3. C and D
4. A and D

Answer 1

Statements A and B are correct. **A.** The membrane potential is brought to the threshold potential (firing level) due to the opening of some voltage-gated sodium channels in response to a threshold depolarizing stimulus. **B.** The rapid depolarization after the firing level is caused by the opening of more voltage-gated sodium channels and the entry of Na^+ into the nerve fiber.

Select the statement that describes Weberian ossicles.

1. It is found in catfish and facilitates sound transmission from the swim bladder to the inner ear.

2. It is found in sea stars and help them in detecting surface vibrations.

3. It is found in anurans and contributes to transmitting sound waves from the eardrum.

4. It is found in snakes and contributes to receiving vibrations from the surroundings.

Answer 1

Weberian ossicles, also known as *Weberian apparatus*, are a series of small bones found in the vertebral column of certain fish species, particularly those belonging to the superorder Ostariophysi, which includes catfish, minnows, and piranhas. These ossicles connect the swim bladder to the inner ear, playing a crucial role in enhancing the fish's ability to detect sound vibrations in water.

Male mating systems have evolved in response to female mating strategies and ecological factors that determine spatial distribution of females. In the table given below, column A represents different mating systems and column B represents different ecological conditions.

Column A			Column B
P.	Resource defense polygyny	i.	Resource is abundant and occurs all over the habitat
Q.	Lek Mating	ii.	Resource is abundant and occurs in clumps
R.	Monogamy	iii.	Resource is limited and occurrence is unpredictable

Which one of the following statements represents all *correct* combinations for the kind of mating system with the corresponding ecological condition?

1. P - i; Q - ii; R – iii
2. P - ii; Q - iii; R - i
3. P - ii; Q - i; R – iii
4. P - iii; Q - i; R - ii

Answer 3

In a plant species, the following pathways contribute to seed color. The wild type phenotype of seed color is red.

- A recessive mutation of gene A leads to white color pigment.
- A recessive mutation of gene B leads to a transparent outer layer and the color of the seed is based on the color of the endosperm.
- The two genes are present on two different chromosomes.
- Often, a yellow or white colored seed has red spots.

Based on the above information, the following statements were made:

A. The probability of getting red colored seeds from a dihybrid cross involving two heterozygous mutants is 9/16.

B. The mutation in gene B could have been caused by a transposable element.

C. A plant producing red seeds would breed true for the seed color.

Which one of the following options represents a combination of all *correct* statements?

1. A only
2. B only
3. A and B
4. B and C

X   Y

A   B

Yellow pigment deposited in endosperm   Red pigment deposited in the outer layer

Transparent seed coat

Answer 2

Transposable elements can cause mutations by inserting into a gene, potentially leading to a recessive phenotype if the element disrupts gene function. This is a plausible explanation for the mutation in gene B, which causes the outer layer to become transparent.
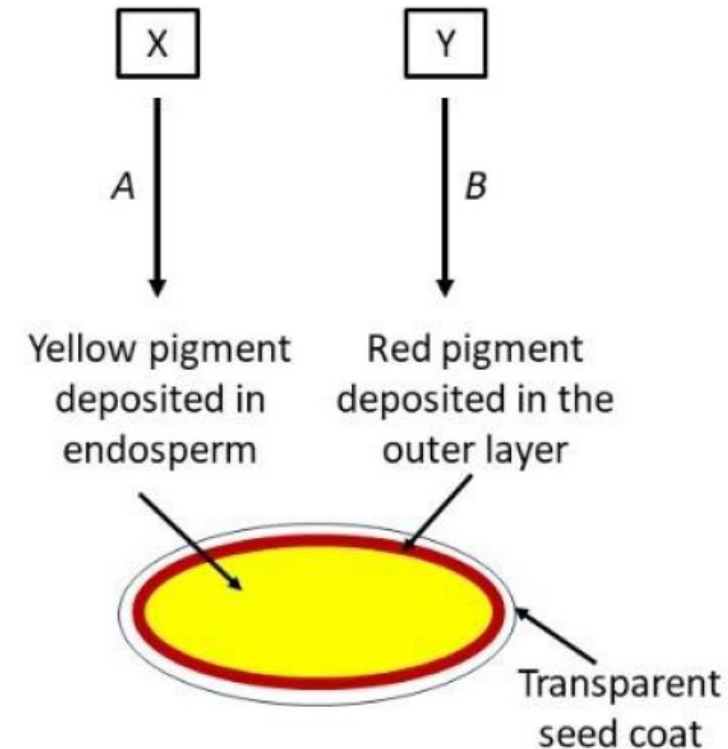
Fgf8 expression in the anterior developing mouse brain induces anterior identity marker expression (anteriorization). The Fgf8 receptor is uniformly expressed in the brain. Which one of the following experiments best demonstrates this fact?

1. Transgenic overexpression of Fgf8 in the posterior of the developing mouse brain causes anteriorization at both ends of the brain.

2. Transgenic overexpression of Fgf8 receptor in the posterior of the developing mouse brain causes anteriorization at both ends of the brain.

3. Grafting the anterior portion of an Fgf8 null developing mouse bra in into the posterior of another developing mouse brain causes the recipient's brain to be anteriorized at both ends.

4. Transgenic overexpression of Fgf8 in the posterior of the developing mouse brain results in no anteriorization.

Answer 1

This question is focused on determining the effect of Fgf8 expression in the developing mouse brain and understanding which experiment best demonstrates that Fgf8 induces anterior identity marker expression when its receptor is uniformly expressed. The first option is the most direct way to demonstrate that Fgf8 induces anterior identity when its receptor is uniformly expressed. Overexpressing Fgf8 in the posterior of the brain and observing anteriorization in that region shows that the presence of Fgf8 can induce anterior identity markers where the receptor is available.

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Salicylic acid (SA) regulates hypersensitive response and effector-triggered immunity at the primary infection site and systemic acquired resistance (SAR) in the distal tissues of the plants. Which one of the following statements regarding the functionality of the Non-expressor of PR genes 1 (NPR1) in the distal tissue is *correct*?

1. NPR1 exists as oligomers in the nucleus and activates hypersensitive response.

2. NPR1 degrades through its binding to NPR3 and leads to activation of SAR response.

3. NPR1 accumulates in the nucleus and leads to activation of SAR response.

4. Binding with NPR4 stabilizes NPR1 in the nucleus, which in turn activates the hypersensitive response.

Answer 3

Asynchronous cultures of *E. coli* were grown in ^{14}N and then shifted to ^{15}N medium containing a chemical C (0 minute) and incubated for two generation times (i.e. 40 minutes). Proportion of hybrid DNA (^{14}N-^{15}N) was measured at various time-points and results are depicted in the following table.

Time	0 minute	10 minutes	20 minutes	30 minutes	40 minutes
Hybrid DNA	0%	40%	40%	40%	40%

From the data, it was concluded that the chemical C inhibits DNA replication.

Which one of the following possibilities could be the likely mode of action of chemical C?

1. It inhibits the initiation of replication.

2. It inhibits the elongation phase of replication.

3. It inhibits the termination of replication.

4. It competes with dNTPs for incorporation into the newly synthesized DNA

Answer 1
Question and answer is not related.

Protein A binds the mRNA for gene B in Hela cells. The protein A mediates the formation of mRNA-protein particles (mRNPs). The addition of a chemical C disrupts mRNPs in Hela cells. The results of the western blot and northern blot analyses are shown below:
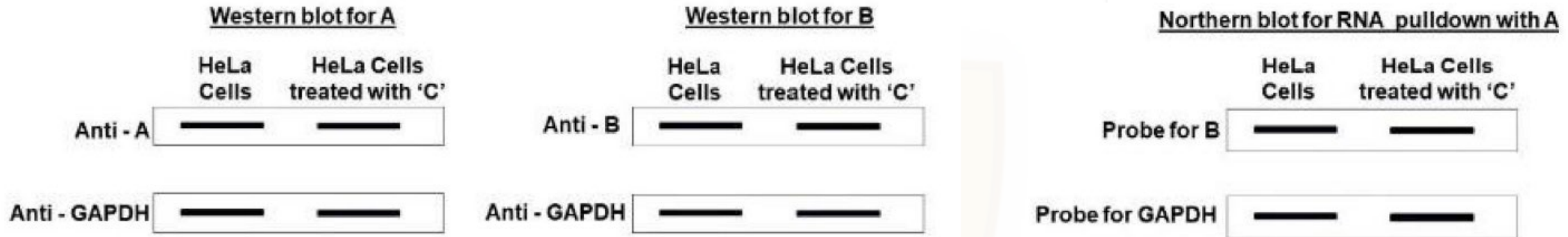
From the above experiments, which one of the following statements is *true*?

1. mRNP disruption does not affect the interaction of protein A and transcript B, or the translation of transcript B.

2. mRNP disruption inhibits protein A interaction with transcript B but not the translation of transcript B.

3. mRNP disruption does not affect the interaction of protein A and transcript B, but affects the translation of transcript B.

4. mRNP disruption promotes protein A interaction with transcript B and translation from transcript B.

Answer 1

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A receptor tyrosine kinase (RTK) dimerizes and autophosphorylates in presence of a ligand. A researcher prepares three constructs that express either the (A) full-length protein having a kinase domain as well as 3 tyrosine residues, (B) the RTK with a non-functional kinase domain but with the 3 tyrosine residues, and (C) the RTK lacking the 3 tyrosine residues but having a functional kinase domain. She expressed these constructs in cell lines lacking the RTK, either singly or in combinations shown in the figure, breaks open the cell and added the ligand of the RTK in presence of radio-labelled ATP. She immunoprecipitated the RTK and analysed the immunoprecipitates by Coomassie staining as shown in the figure, followed by autoradiography.
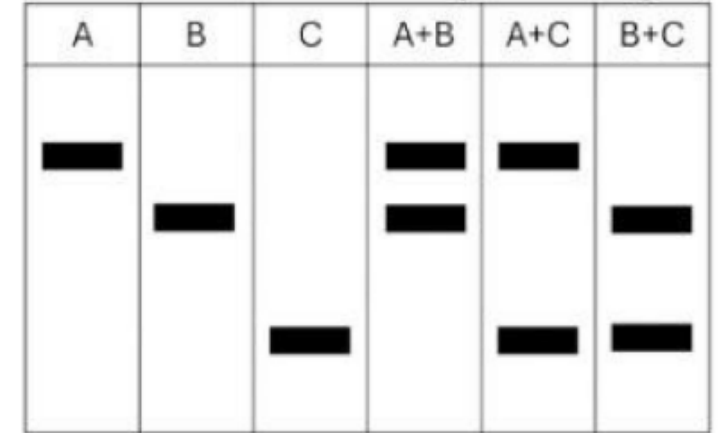
Which one of the following autoradiograms would the researcher expect?
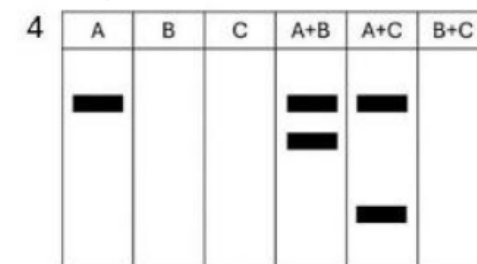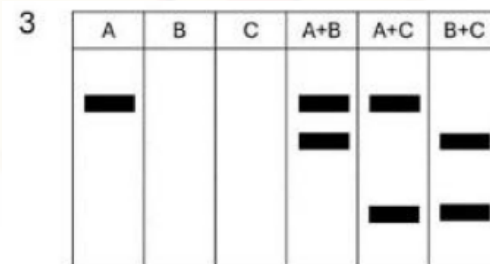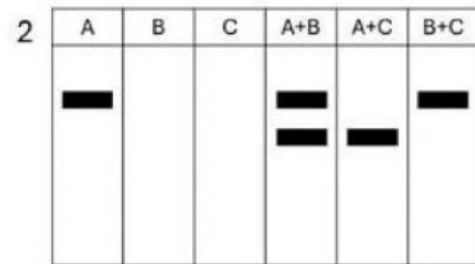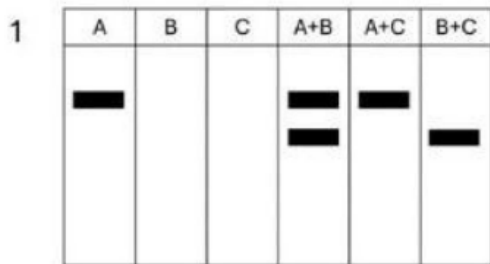
Answer 1

Given below are mammals and their location in India:

	Mammal		Location
a	Hangul	i.	Little Rann of Kutch
b	Golden Langur	ii.	Manas National Park
c	Sangai	iii.	Dachigam National Park
d	Wild Ass	iv.	Keibul Lamjao National Park

Which one of the following options represents the *correct* match between the mammals and their locations?

1.   a-iv, b-i, c-i ii, d-ii

2.   a-iv, b-iii, c-ii, d-i

3.   a-iii, b-ii, c-iv, d-I

4.   a-ii, b-iii, c-iv, d-i

Answer 3

This question is information based.

For detail you can consult **Fundamental of Ecology and Environment, 4ᵗʰ edition**

A uniformly labelled (^{32}P) single-stranded DNA (ssDNA) was incubated with a homologous double-stranded DNA (dsDNA) in the presence of Rad51 and/or RPA along with ATP or the non-hydrolysable ATPλS to study a three-strand exchange reaction. The reactions were terminated at various time points, DNA were digested with EcoRI followed by electrophoresis and autoradiography. Results are shown in the figure below.

Three-strand exchange reaction

Uniformly labelled DNA
Vertical bars: EcoRI sites

Rad51	+	+	+	+	+	+	+
RPA	+	+	-	+	+	+	+
ATP	+	-	+	+	+	+	+
ATP-γ-S	-	+	-	-	-	-	-
Time (min.)	60	60	60	10	30	60	90
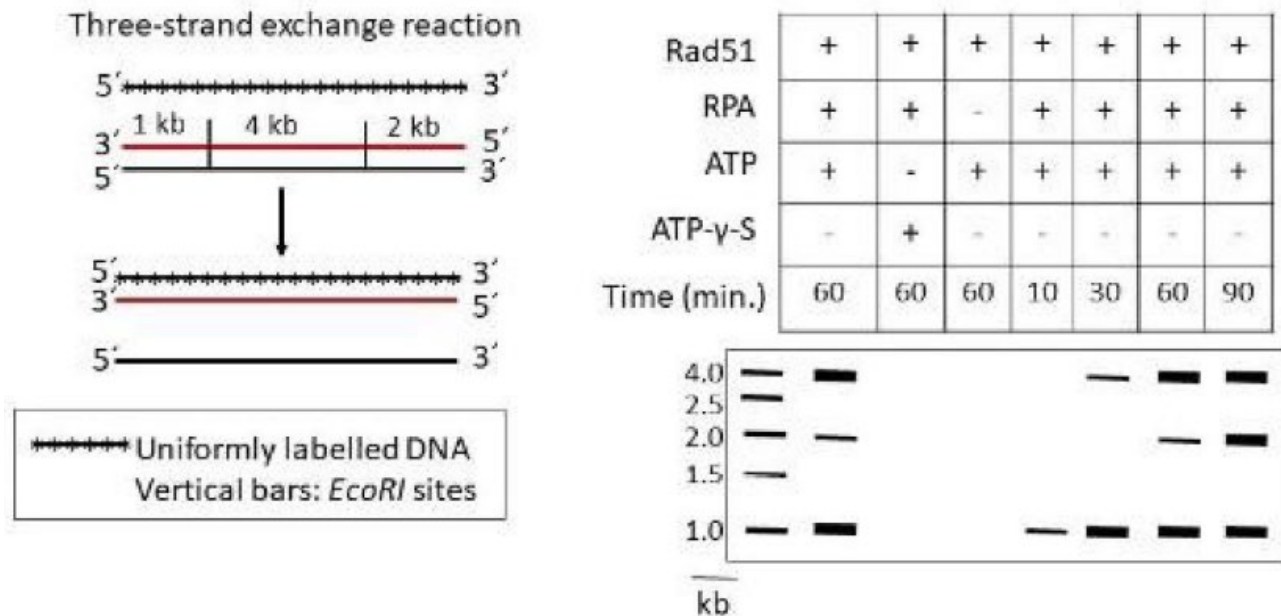
Based on the above data, which one of the following statements is *INCORRECT*?

1. Rad51 requires ATP hydrolysis for strand exchange reaction.

2. Strand exchange does not take place in the absence of RPA.

3. The polarity of strand-exchange reaction is in the 3· to 5' direction.

4. The rate of strand-exchange is 7 kb/hour.

Answer 3

The glomerular ultrafiltration coefficient (K_f) can be changed by the mesangial cells producing a decrease in K_f largely due to a reduction in the area available for filtration. The following statements are made about some agents that affect the mesangial cells.

A. Norepinephrine causes contraction of mesangial cells.

B. Angiotensin II causes relaxation of mesangial cells.

C. Histamine causes relaxation of mesangial cells.

D. Atrial natriuretic factor (ANF) causes relaxation of mesangial cells.

Which one of the following options represents combination of all *correct* statements?

1. A and B
2. B and C
3. C and D
4. A and D

Answer 4

Norepinephrine causes contraction of mesangial cells: This statement is correct. Norepinephrine, acting through adrenergic receptors, can induce contraction of mesangial cells, leading to a decrease in the surface area available for filtration, thereby reducing K_f.

Angiotensin II causes relaxation of mesangial cells: This statement is incorrect. Angiotensin II generally causes contraction of mesangial cells, reducing the filtration surface area and thus decreasing K_f.

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The following four DNA oligos are mixed in equimolar concentration, heated to 95°C, and slowly annealed in a microcentrifuge tube.

5' GCG GGA ATT TA 3'

5' GCC TAC TCC CGC 3'

5' CGA TGG GTA GGC 3'

5' TAA ATC CAT CG 3'

Which of the following secondary structures will predominantly be present?

1. Two separate B-forms of double-stranded DNA structures

2. Four individual stem-loop DNA structures

3. Two separate Z-forms of double-stranded DNA structures

4. A four-stranded Holliday junction

Answer 4

Following are the different critical reaction steps involved in the oxidation of lipids in many organisms.

A. **Reaction of fatty acyl-CoA with carnitine**

B. **Thiolysis**

C. **Hydrolysis of triacylglycerol by lipase**

D. **Activation of fatty acid by conjugating to CoA**

E. **Hydration**

Choose the *correct* sequence of reaction steps in ascending order.

1. **C-D-A-E-B**
2. **C-E-D-A-B**
3. **E-D-A-C-B**
4. **D-E-B-C-A**

Answer 1

Mitochondrial β-oxidation

Hydrolysis of triacylglycerol by lipase and release of fatty acids

Fatty acid activation

Transport across the mitochondrial membrane (carnitine shuttle)

Oxidation – Hydrolysis – Oxidation - Thiolysis

Given below are a list of sub-cellular compartments (Column X) and markers (Column Y).

Column X		Column Y	
Subcellular compartments		Markers	
A	Endoplasmic reticulum	i	LC3b
B	Golgi apparatus	ii	HSP60
C	Autophagosome	iii	Protein disulphide isomerase
D	Mitochondria	iv	Mannosidase II

Which one of the following options *correctly* matches the subcellular compartments with their markers?

1. A-iii , 8-iv, C-i, D-ii
2. A-iv, 8-iii, C-ii, D-i
3. A-iii , 8-iv, C-ii, D-I
4. A-ii, 8-iv, C-i, D-iii

Answer 1

For detail you can consult *Chapter 3 Cell structure and Function* (**Fundamental and Practice, Life Sciences-1, 9th Edition**)

Single-stranded DNA binding properties of three DNA repair proteins (A, B, and C) were investigated. A biotinylated single-stranded DNA was prepared and incubated with the proteins in different combinations as shown below. This was followed by streptavidin pull-down to enrich ssDNA-bound proteins, which were detected by western blot analyses using specific antibodies.

Which one of the following statements is NOT a correct conclusion from the above study?

1. Protein A binds to the ssDNA.
2. Protein B does not bind to ssDNA.
3. Protein C destabilizes the binding of protein A to ssDNA.
4. Protein C interacts with protein A but not with protein B.

Protein A	-	+	-	-	+	+
Protein B	-	-	+	-	+	+
Protein C	-	-	-	+	-	+

Streptavidin pull down

Western blot

Answer 4

Given below is a list of regulatory RNAs (Column X) and their modes of action {Column Y).

Column X		Column Y	
	Regulatory RNA		Mechanism for the control of gene expression
A.	Riboswitch	i.	Base-pairing with specific mRNAs and controlling their stability and their translation.
B.	MicroRNA (miRNA)	ii.	Change their conformation when bound to small molecules, usually metabolites.
C.	Small interfering RNAs (siRNAs)	iii.	Complementary base pairing followed by RISC-mediated mRNA cleavage.

Which one of the following options represents all *correct* matches between Column X and Column Y?

1. A-ii, B-i, C-iii
2. A-i, B-ii, C-iii
3. A-iii, B-i, C-ii
4. A-iii, B-ii, C-i

Answer 1

DELLA proteins are known to interact with phytochrome interacting factors (PIFs) and regulate genes involved in etiolation in *Arabidopsis*. Following are certain statements regarding the function of DELLAs under dark and light conditions:

A. In dark, high level of gibberellic acid (GA) helps DELLAs to directly bind to PIFs.

B. During light, the level of GA goes down and helps DELLA-PIF complex to bind to the promoters of the etiolation responsive genes.

C. Binding of DELLA proteins to PIFs prevents the transcription of PIF induced genes, leading to photomorphogenesis.

D. Skotomorphogenesis is due to the degradation of DELLA proteins and binding of the PIfs to the etiolation responsive genes.

Which one of the following options represents the combination of all *correct* statements?

1. A and C
2. B and D
3. A and B
4. C and D

Answer 4

Protein phosphatase 2A (PP2A) is a critical regulator of Cdk1 substrates during the cell cycle. The B55 subunit of PP2A influences the substrate selectivity, localization, and regulation of the enzyme. Given below are a few statements about PP2A and its regulation during the M-phase of the cell cycle.

A. PP2A-B55 activity is high during interphase but inhibited during early mitosis when M-Cdk activity rises.

B. M-Cdk1 turns off PP2A-B55 via the phosphorylation of an intermediary protein kinase called Greatwall.

C. M-Cdk1 turns on PP2A-B55 via the phosphorylation of an intermediary protein kinase called Greatwall.

D. When anaphase is initiated and M-Cdk1 activity declines, PP2A-B55 promotes dephosphorylation of Cdk1 substrates.

Which one of the following combinations represents all the *correct* statements?

1. A, B, and D
2. A, C, and D
3. C and D only
4. A and B only

Answer 1

The following statements refer to mechanisms that may confer resistance to antibiotics in bacteria.

A. Enzymes that can break down the antibiotic.

B. Efflux systems to pump out the antibiotic.

C. CRISPR-mediated defence against the antibiotic.

D. Antitoxins that can sequester the antibiotic.

E. Cell wall modification.

Which one of the following options represent the combination of all *correct* statements?

1. A, Band E only
2. A, B and C only
3. A, B, C and D
4. A, B, C and E

Answer 1

The feedback control of the branched amino acid biosynthesis pathway in Arabidopsis is given below. The activity of Acetohydroxyacid Synthase (AHAS) enzyme is feedback inhibited by Leucine and Valine synergistically, whereas Isopropyl malate synthase (IPMS) enzyme activity is inhibited by Leucine only. Feedback resistant mutant lines of AHAS and /PMS genes are *ahas*2-1^D and *ipms*1-1^D, respectively.

The phenotype of these feedback resistant mutants was analyzed by growing them in the following Murashige and Skoog (MS) medium combinations.

A. MS medium only

B. MS medium supplemented with Leu only

C. MS medium supplemented with Val + Leu

D. MS medium supplemented with Val only

Which one of the following statements is *correct*?

1. *ahas*2-1^D will grow in (C) only, and *ipms*1-1^D will grow in (B) only.

2. *ahas*2-1^D will grow only in (D) and *ipms*1-1^D will grow in both (A) and (B).

3. *ahas*2-1^D will grow in both (A) and (C) and *ipms*1-1^D will grow in both (A) and (B).

4. Both *ahas*2-1° and *ipms*1-1^D mutants will grow in (A) only.

Pyruvate → AHAS → 2-OIV → Valine; IPMS → Leucine

⊣ Feedback regulation
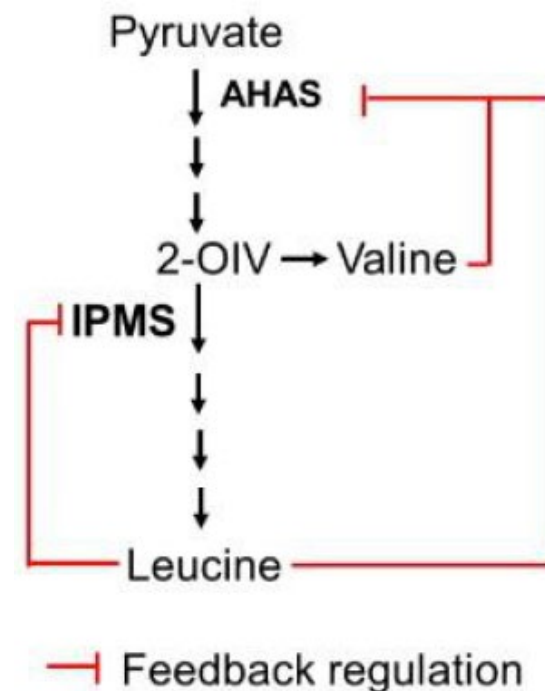
Answer 3

Different leads used in electrocardiography (Column X) and the electrode placement and connections (Column Y) are listed below:

	Column X		Column Y
	ECG leads		Electrode placement and connections
a	Standard limb lead I	i	Left leg – positive Right arm - negative
b	Standard limb lead II	ii	Left leg- positive Left arm- negative
c	Standard limb lead III	iii	Right arm- positive, Left arm and left leg connected together- negative
d	Augmented limb lead aVR	iv	Left arm - positive Right arm - negative

Which one of the following options represents the *correct* match between Column X and Column Y?

1. a-i , b-ii, c-iii, d-iv

2. a-ii, b-iii, c-iv, d-i

3. a-iii, b-iv, c-i, d-ii

4. a-iv, b-i, c-ii, d-iii

Answer 4

Given below are a few statements related to inheritance biology.

A. Quantitative traits are characterized by discontinuous variations in the phenotype.

B. Polygenic traits never show a normal distribution of phenotypic variability.

C. Association mapping captures wider genetic diversity than biparental linkage mapping.

D. Bulked segregant analysis can be used for mapping of monogenic qualitative traits.

Which one of the following options represents a combination of all *correct* statements?

1. A and C
2. B and D
3. A and B
4. C and D

Answer 4

The mutation rate refers to the frequency at which new mutations arise in the genome of an organism and is typically expressed as:

Mutation rate = Number of observed mutations / Total number of opportunities for mutations

Which one of the following factors will NOT influence the opportunities for mutations?

1. Generation time
2. DNA repair efficiency and replication fidelity
3. Exposure to mutagens
4. Population size

Answer 4

Following statements were made for the production of cisgenic plants.

A. In cisgenics, the donor sequence does not necessarily replace the native gene sequence but is added to the recipient species.

B. Cisgenic plants might contain DNA sequences such as T-DNA borders from the plasmid vector.

C. Insertion of a cisgene may result in a gene mutation at the site of insertion similar to that of transgenics.

D. With regard to the species gene pool, cisgenesis does not alter the gene pool of the recipient species.

E. Both cisgenesis and transgenesis can use the same DNA transformation methods to introduce the respective gene constructs into the recipient plants.

Which one of the following options represents the combination of all *correct* statements?

1. B, C and E only
2. A and D only
3. A, C, D and E only
4. A, 8 , C, D and E

Answer 4

The table below represents a list of geographical regions and avian fauna.

	Geographical region		Avian fauna
a.	Western Himalayas	i.	Rufous babbler
b.	Western Ghats	ii.	Narcondam hornbill
c.	Peninsular India	iii.	Red crossbill
d.	Andaman-Nicobar Archipelago	iv.	Yellow-throated bulbul

Which one of the following options represents the combination of all *correct* matches:

1. a-ii, b-iv, c-iii, d-i
2. a-i, b-iii, c-ii, d-iv
3. a-ii, b-iii, c-iv, d-i
4. a-iii, b-i, c-iv, d-ii

Answer 4

This question is information based.

For detail you can consult **Fundamental of Ecology and Environment, 4ᵗʰ edition**

Stable coexistence is possible in a classical two-species Lotka-Volterra competition model when

1. intraspecific competition is stronger than interspecific competition.

2. intraspecific competition is weaker than interspecific competition.

3. inter- and intra-specific competitive effects are balanced.

4. interspecific effects are offset by demographic stochasticity.

Answer 1

The case of stable coexistence, the isoclines cross one another, but for both species carrying capacities are lower than the other's carrying capacity divided by the competition coefficient. Rather than outcompeting one another, the two species are able to coexist at stable *equilibrium point*. An equilibrium point occurs where the isoclines cross. In this case, both species have less competitive effect on each other i.e., weak interspecific competition. Coexistence occurs when intraspecific competition is greater than interspecific competition. The outcome of this type of competition is the stable coexistence of both species.

For detail you can consult **Fundamental of Ecology and Environment, 4th edition**

Eukaryotic transcription factors TF1 and TF2 bind to independent cis regulatory elements (Cis1 and Cis2, respectively) upstream of TATA box and positively regulate gene expression. Histone modifier 1 (HM1) binds to TF1 but not to TF2. In order to determine how genes are regulated by these three factors, an *in vitro* transcription and translation assay was set up. A packaged DNA containing region from Cis1 to Cis2, along with eukaryotic minimal promoter fused upstream of a luciferase gene, was purified. The luciferase activity, upon addition of a combination of TF1 , TF2 and/or HM1 , in presence of RNA polymerase and translation mix is plotted below.

Which one of the following models best represents the results above?

1. TF2 activates luciferase expression independent of TF1 and HM1.

2. HM 1 activates binding of either of TF1 or TF2 to their cognate Cis elements to activate luciferase expression.

3. TF1 binds to Cis1, recruits HM1 to modify DNA al lowing TF2 to bind Cis2 to enhance luciferase expression.

4. TF2 binds to Cis2, recruits HM1 to modify DNA allowing TF1 to bind Cis1 to activate luciferase expression.
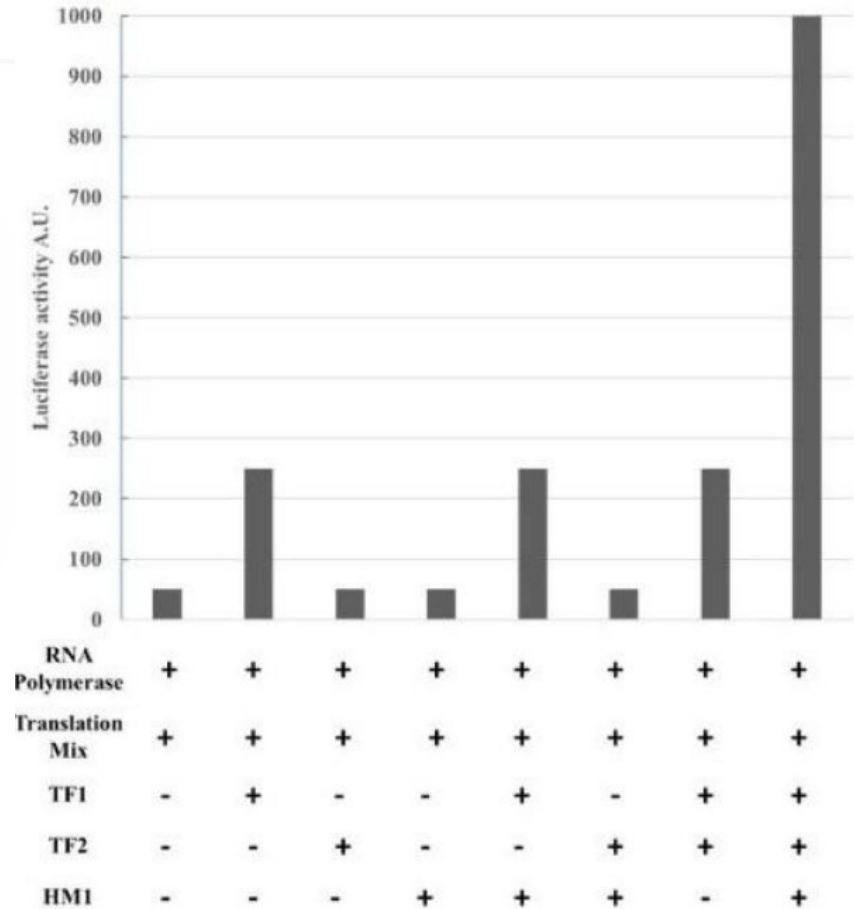
Answer 3

A region of a eukaryotic chromosome is heavily transcribed by RNA polymerase II. Given below are a few properties of such a chromatin.

A. DNaseI hypersensitivity

B. High CpG methylation

C. Occupied by macroH2A

D. High histone acetylation

Choose the option that has all *correct* properties.

1. A and C only

2. C and D only

3. A, B and D

4. A and D only

Answer 4

Actively transcribed regions of chromatin are more open and accessible, making them hypersensitive to DNase I digestion. High CpG methylation is typically associated with transcriptionally inactive regions of chromatin. High levels of histone acetylation are associated with open chromatin and active transcription.

The following graphs represent the effect of two environmental conditions (E1 and E2) resulting in two optimal phenotypes (O_{E1} and O_{E2}) for their respective environmental conditions.

Environmental condition
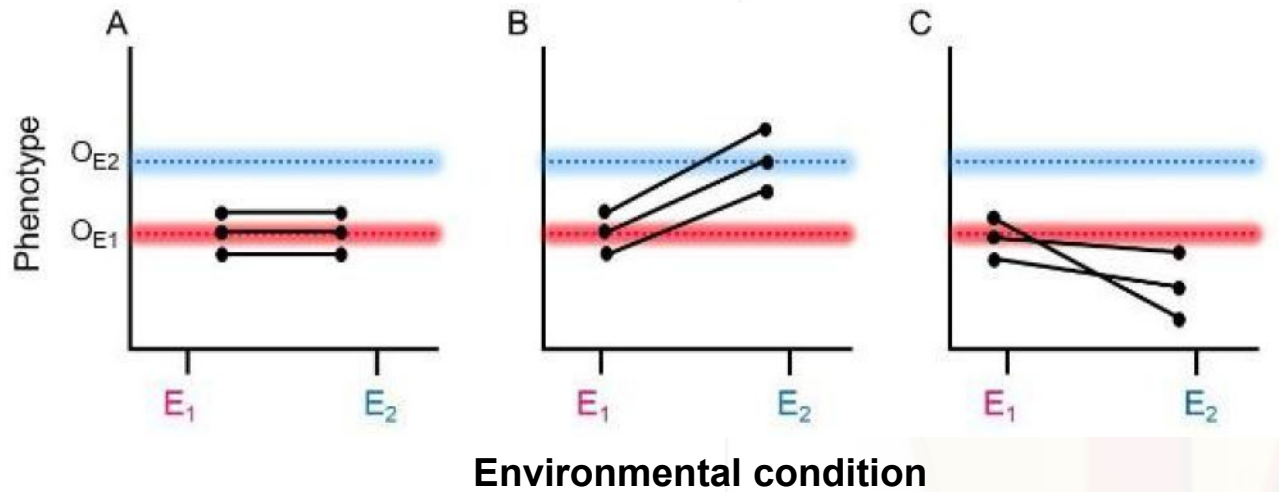
Which one of the options represents phenotypic plasticity?

1. A only
2. B only
3. B and C
4. A and B

Answer 3

Phenotypic plasticity refers to the ability of a single genotype to produce different phenotypes in response to varying environmental conditions. This adaptive trait allows organisms to survive and reproduce in diverse environments by altering their physiology, morphology, behavior, or development based on the external stimuli they encounter.

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The phylogenetic tree given below shows sing le nucleotide polymorphisms observed among four individuals of the scorpion species *Deccanometrus bengalensis*.
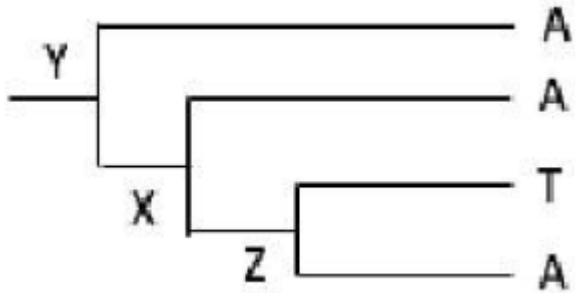
Select the option that represents the correct combination of ancestral nucleotides at nodes X, Y and Z using the principle of parsimony.

1. Y : A, X : A, Z : A

2. Y : A, X : A or T, Z : A or T

3. Y : A, X : A, Z : A or T

4. Y : A or T, X : A or T, Z : A or T

Answer 3

In evolutionary biology, the principle of parsimony is used to infer evolutionary relationships among species by choosing the phylogenetic tree that requires the fewest evolutionary changes, or steps, to explain the observed traits.

The figure summarizes the observation following a cross between two haploid strains of *Neurospora crassa* having alleles A and a, respectively.

The following statements were made:

A. In 'I', segregation of alleles occurred in Anaphase II.

B. Crossing over between the centromere and the gene occurred in 20% of the meiocytes.

C. With reference to the two non-recombinant parental chromosomes, there are 6 different ways by which they can orient themselves at the equatorial plate.

D. The gene is 20cM away from the centromere.

Which one of the following options represents a combination of all *correct* statements?

1. A and B only
2. B and Conly
3. C and D only
4. B, C and D

Octads

I	II	III	IV	V	VI

● A
○ a

No. of asci observed	16	14	18	12	135	105

Total = 300
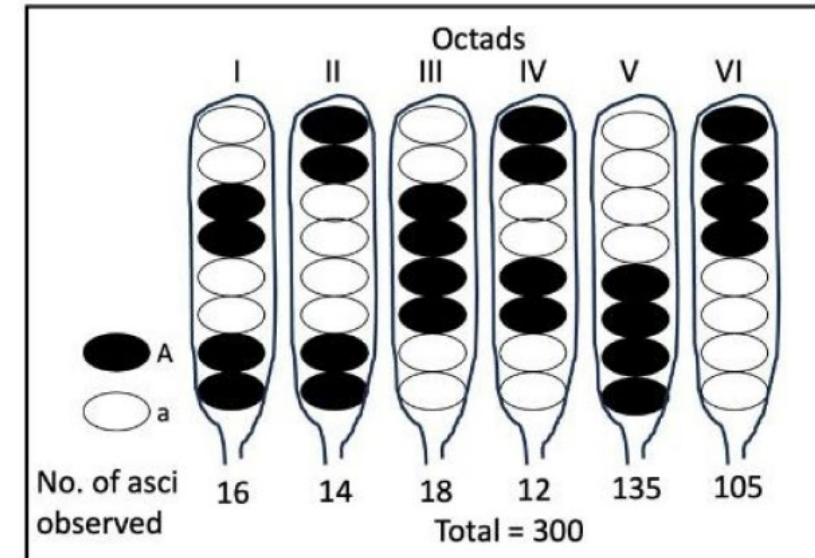
Answer 1

If a cross over does occur between the gene and its centromere, the *A* and *a* allele do not become separated until the second meiotic division. This separation is called *Second Division Segregation* (SDS). So, second division segregation deviates from the 4 : 4 pattern. Depending on the relative locations of the two chromatids that participated in the crossover, the ascus will contain a 2 : 2 : 2 : 2 or 2 : 4 : 2 pattern

$$\text{Map distance between a gene and its centromere} = \frac{\frac{1}{2} \times \text{Number of SDS asci}}{\text{Total number of asci}} \times 100$$

The following experimental manipulations were carried out with Xenopus embryo.

<u>Manipulation X</u>: Exposure to ultra violet radiation leading to the failure of cortical rotation.

<u>Manipulation Y</u>: Gastrulae treated with lithium chloride, an agonist of canonical Wnt signaling.

The following statements were made with respect to the above manipulations and genes involved in setting up dorso-ventral polarity in amphibians.

A. The phenotype obtained due to manipulation X can be rescued by injection of *noggin* in 1-cell embryo

B. *Chordin* mRNA will be enriched in embryos of manipulation X as compared to those of manipulation Y

C. Injection of cDNA for *chordin* into ventral blastomeres leads to the induction of a secondary axis.

D. Experimentally depleting β-catenin transcripts in 1-cell embryo by antisense oligonucleotides leads to phenotype similar to that obtained from manipulation X.

Which one of the following options represents all *correct* statements?

1. A, C and D
2. B, C and D
3. A and B only
4. B and C only

Answer 1

To test the lever-arm model of myosin movement, an investigator utilizes recombinant DNA technology to attach myosin head to various length of neck domains. In the schematics shown below (1-4), the y-axis represents the velocity of myosin in µm/sec on the actin filament, and the x-axis shows the recombinant myosins (a-d; shown on the left) that were utilized to calculate the velocity. Considering that all the appropriate conditions were applied to estimate the velocity of recombinant myosin, choose the graph that correctly represents the velocity of recombinant myosin.
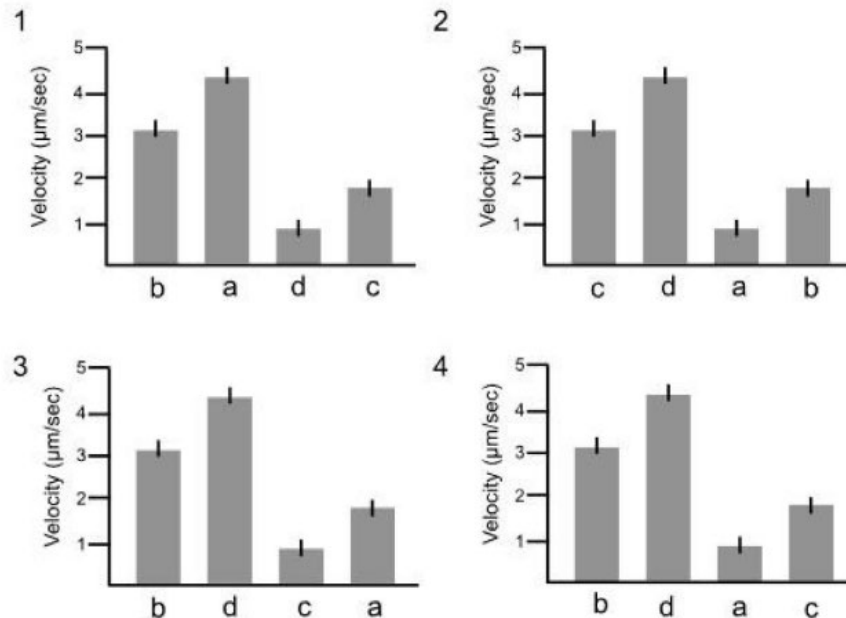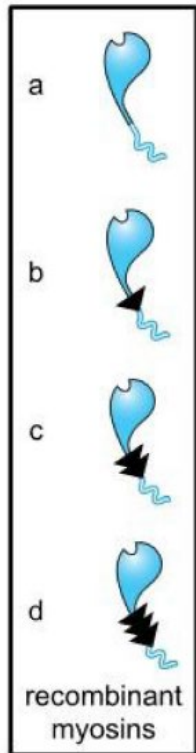
Answer 2

The surface electrostatic potential map of an 18 kDa protein is shown below. Shades of blue and red on the surface denote positively and negatively charged surfaces, respectively.

Which one of the options represents the most likely natural substrate/s for the protein?

1. Fatty acids and cellulose

2. DNA and RNA

3. DNA and cellulose

4. Only cellulose

Answer 2

180°

Blue +5.0 kT/e

0

Red -5.0 kT/e
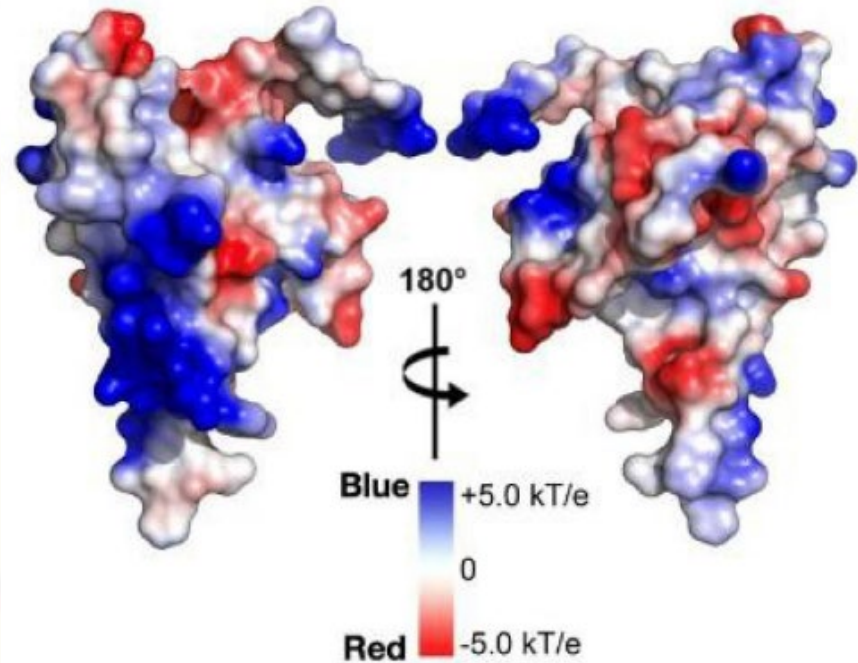
Five different strains of *Salmonella* (1, 2, 3, 4, 5) which can utilize lactose (Lac$^+$) as the sole carbon source but cannot synthesize arginine (Arg$^-$) are mixed with five other strains (6 ,7,8,9,10) that cannot utilize lactose (Lac$^-$) and can make arginine (Arg$^+$). These strains are mixed in all possible combinations and plated on appropriate plates to get Lac$^+$ Arg$^+$ recombinants. The following results were obtained, where H represents 'high numbers of recombinants', L refers to 'low numbers of recombinants' and O represents 'no recombinants'.

Strain No.	1	2	3	4	5
6	H	O	O	H	L
7	H	O	O	H	L
8	O	H	H	O	O
9	O	L	L	O	O
10	O	H	H	O	O

On the basis of these results, the sex type (either Hfr, F$^+$ or F$^-$) to each of these strains was assigned.

A. Strains 2,3,6,7 are F$^-$

B. Strains 2,3,5,6,7,9 are F$^-$.

C. Strains 1,4,8,10 are F$^+$

D. Strains 1,4,8,10 are Hfr

Which one of the following options represents a combination of all *correct* statements?

1. A and C
2. A and D
3. B and C
4. B and D

Answer 2

Consider a species of group-living bird in which individuals produce alarm calls to alert group members of the presence of a predator. The alarm call confers fitness benefits to the caller as it helps group members (composed of genetic relatives) escape the predator. However, alarm calling also makes the caller more conspicuous to the predator. Individuals of this species in a population have four phenotypes for the loudness of alarm calls they produce in the order P < Q < R < S. The graph below gives the cost and benefit functions for alarm calling behaviour for the four phenotypes.

Which one of the following phenotype frequencies represents the *correct* outcome of natural selection?

1. Phenotype frequency: P = Q = R < S
2. Phenotype frequency: S > R > Q > P
3. Phenotype frequency: Q > (P = R) > S
4. Phenotype frequency: Q > P = R = S

Answer 3

In animal behavior studies, the *cost-benefit ratio* is a concept used to analyze the evolutionary advantages of certain behaviors. Understanding the cost-benefit ratio in animal behavior provides insights into how animals make decisions that maximize their evolutionary fitness. This ratio helps determine whether a behavior is advantageous from an evolutionary perspective.
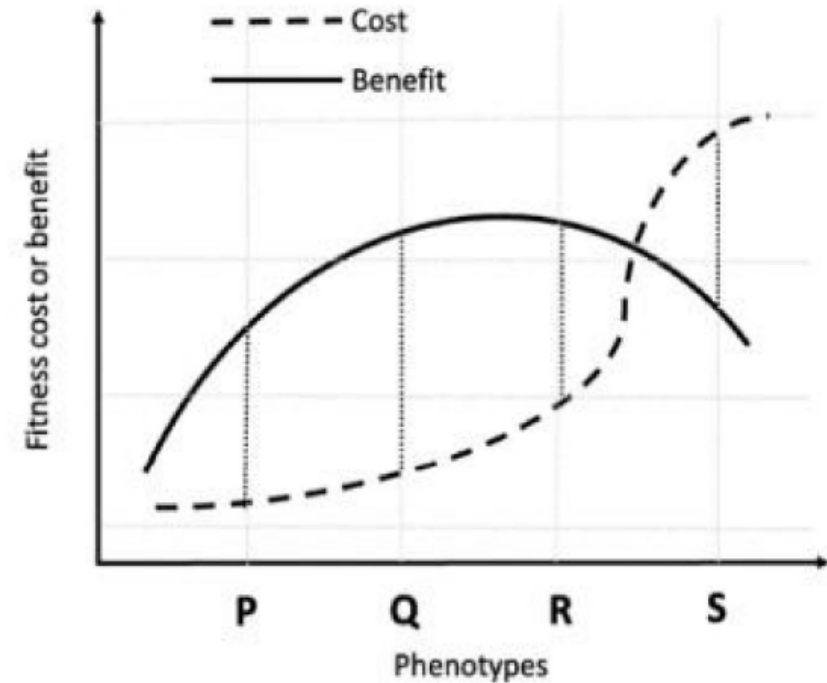
A tree grows at 0.5 meter per day under optimal tropical conditions. Assuming the stem consists entirely of cellulose fibers, how many D-glucose residues must be added per second to reach the above growth rate? The length of D-glucose in cellulose is about 0.45 nm.

1. 1200-1300 residues

2. 12800-12900 residues

3. 120800-120900 residues

4. 2800-2900 residues

Answer 2

Tree growth rate in meters per second: 0.5/86,400 = approx. 5.8×10^{-6} meters per second

The length of one D-glucose residue in cellulose is approximately 0.45 nm (0.45×10^{-9} meters).

Number of residues per second = (Growth rate in meters per second) / (Length of one residue in meters)

$$= 5.8 \times 10^{-6} / 0.45 \times 10^{-9}$$

Approximately 12,900 residues per second.

Wild-type *Drosophila* have a pair of wings on one segment and a pair of halters on the adjacent posterior segment. Wild type four-winged insects like dragonflies do not have halteres. Ultrabithorax (Ubx) is a homeobox gene. Ubx mutants of *Drosophila* have two pairs of wings and no halteres. In relation to Ubx function, the two-winged and four-winged insect species differ based on

1. Ubx expression levels in segments that give rise to wings/halteres.

2. Ubx regulation at different developmental times in segments that give rise to wings/halteres.

3. targets of Ubx in segments that give rise to wings/halteres.

4. Ubx copy number and paralog evolution.

Answer 3

The following statements describe possible nomenclature rules for plants and animals.

A. **A plant and an animal cannot bear the same binomial Latin name.**

B. **The valid name of a taxon is the oldest available name that has been applied to it and which is validly published.**

C. **A species may not be removed from a genus once described.**

D. **Only a single specimen 'holotype' acts as the primary "name bearer" for any species.**

Select the option that contains all accepted statements about nomenclature rules.

1. **A and B**

2. **B and D**

3. **C and D**

4. **A and C**

Answer 2

In *taxonomy*, the rules for naming plants and animals are governed by different codes: the International Code of Botanical Nomenclature (ICBN) for plants and the International Code of Zoological Nomenclature (ICZN) for animals. Species can be reclassified into different genera based on new evidence or changes in taxonomic understanding.

A cross was made between wild type female *Drosophila melanogaster* and mutant males which are yellow bodied (*y*) and crossveinless (*cv*). The two genes are present on the X-chromosome. The F1 progeny was sib-mated and the observation of F2 progeny is tabulated below.

Phenotype	No. of male progeny	No. of female progeny
wild type	45	100
yellow body and crossveinless	40	0
yellow body	6	0
crossveinless	9	0
Total no. of progeny analyzed = 200		

With regard to the above analysis, which one of the following statements is *correct*?

1. The genetic distance between the two genes is 7.5 cM.

2. If the mapping was done with a 3rd marker which lies between y and cv, the genetic distance is likely to increase, but never decrease.

3. If a larger progeny size was analyzed, more double crossovers will be identified leading to decrease in the genetic distance.

4. If a reciprocal parental cross was carried out, no recombinants would be observed in the F2 progeny as there is no crossing over in 0. melanogaster males.

Answer 2

The genetic distance between the two genes is 15 cm. In male *Drosophila* there is no crossing over during meiosis. Identifying more double crossovers would generally lead to an increase in the estimated genetic distance, not a decrease. If the reciprocal cross involves a *D. melanogaster,* there will be recombination events in the male gametes.

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Results of immunoprecipitation (IP) of HA-Yfg are shown below.

Given below are options of controls that could be used to confirm that F1β actually associates with HA-Yfg.

A. Include a lane where α-HA is not added but Protein A-Sepharose is added

B. Include a lane where neither α-HA nor Protein A-Sepharose are added

C. Include a lane where α-HA is added but Protein A-Sepharose is not added

D. Include a lane where α-Myc is added instead of α-HA before addition of Protein A-Sepharose.

Which one of the following options represent(s) the most appropriate control(s)?

1. A only
2. A and B
3. A and D
4. C and D

Protein A- Sepharose   −   +

α-HA   −   +

HA-Yfg

F1β

Lysate   IP
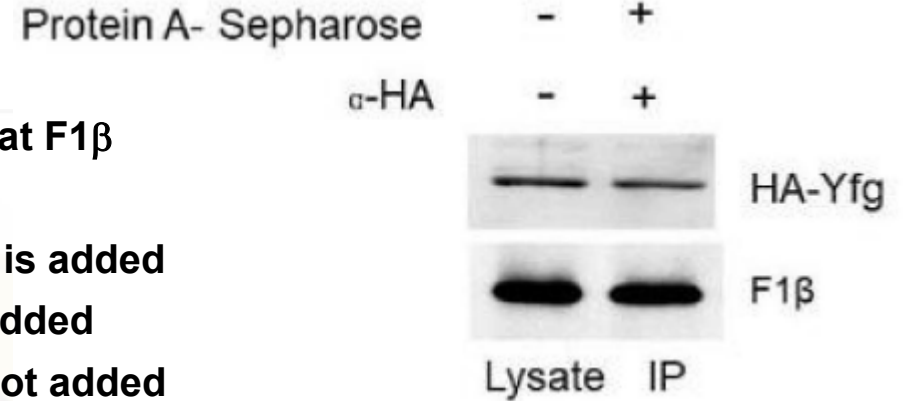
Answer 3

Mutants of bacteriophage that carry deletions can be used to rapidly locate mutational sites of newly obtained mutants. The mapping is based on whether wild type recombinants can be recovered when the deletion mutant and the novel mutant are brought together.

Four independent deletions (1 to 4) of a region were used to map 4 novel mutations (A to D).

The deletions (starting from a fixed site) are shown below (the lines denote the region of deletion):

Deletion 1 ━━━━━━━━━━━━
Deletion 2 ━━━━━━━━━━━━━━━━
Deletion 3 ━━━━━━━━━━━━━━━━━━━━━
Deletion 4 ━━━━━━━━━━━━━━━━━━━━━━━

The results of mapping are summarized in the table, where '+' denotes the recovery of wild type recombinants and '- ' the inability to do so.

	A	B	C	D
1	−	+	+	+
2	−	+	+	−
3	−	−	+	−
4	−	−	−	−

Further it was observed

- that out of the 4 novel mutants no revertant was observed for mutant A
- mutant B and C do not complement each other

The following conclusions were made:

A. Mutation A lies within the region of deletion 1.

B. Mutations can be ordered as A-D-B-C.

C. Mutant A could be a deletion.

D. Mutants B and C are located on 2 independent cistrons.

Which one of the following options represents a combination of all *correct* statements?

1. A, B and C
2. B, C and D
3. A, C and D
4. A and B only

Answer 1

In a population with density-dependent effects on births and deaths due to intraspecific competition, the net recruitment curve is dome-shaped because

1. density-dependence is lowest at intermediate density.

2. of undercompensating density-dependence and population size at intermediate density.

3. death rates are lowest at low density.

4. mortality rates are density-independent at intermediate density.

Answer 2

Undercompensating density-dependence refers to a situation where the effects of density on population growth do not completely offset the changes in population size. At low densities, the birth rate exceeds the death rate, leading to net increase in population size. At high densities, the death rate exceeds the birth rate, leading to net decrease in population size. At intermediate population densities, the birth rate and death rate balance each other out, leading to the highest net recruitment before density-dependent effects start to dominate and reduce the population growth rate.

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A researcher wants to stitch two fragments of DNA, "A" and "B" (shown in the figure below), using PCR. She uses primer pairs "a" and "b" to amplify DNA "A". Thereafter, she mixes equal concentrations of PCR amplified "A" and DNA "B" to set up a PCR using primers " a' " and "c".

The plus strand sequences of the two DNA fragments are given below (" .. .. " stands for any of the four nucleotides):
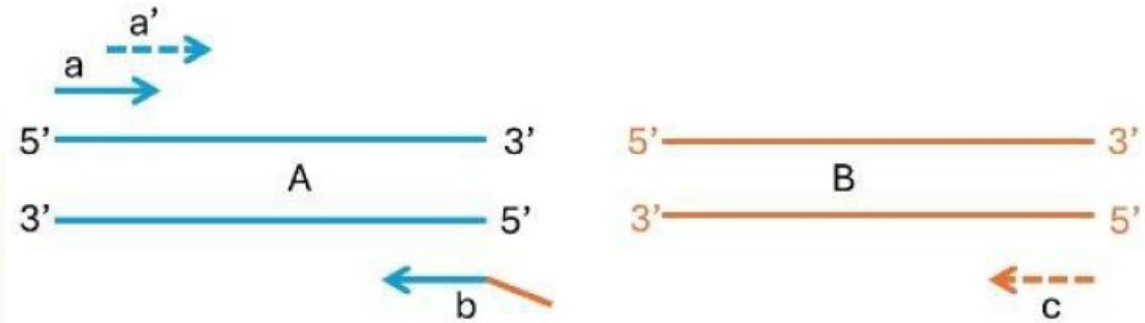
A:
5'-AGAGAGAGAGAGAGAG.................GAGAGAGAGAGAGAGAGAGAG - 3'
B:
5'-AGCTTGCATGCCTGCAGGTCGACT.......................... TAGACGATGA - 3'

Which one of the following options represents the *correct* sequence of primer "b"?

1. 5'-CTCTCTCTCTCTCTCTCTTCGAACGTACGGACGTCCAGCTGA-3'

2. 5'-AGTCGACCTGCAGGCATGCAAGCTTCTCTCTCTCTCTCTC-3'

3. 5'-AGCTTGCA TGCCTGCAGGTCGACTCTCTCTCTCTCTCTCTC-3'

4. 5'-AGTCGACCTGCAGGCATGCAAGCTGAGAGAGAGAGAGAG-3'

Answer 2

Following statements have been made about vaccines.

A. Covaxin is a killed cell vaccine and Corbevax is a subunit vaccine.

B. Oral polio vaccine is given as a live attenuated vaccine to adults and as a killed vaccine to children.

C. Third generation vaccines against smallpox are based on attenuated Vaccinia virus.

D. MMR vaccine is given to children to protect them against diphtheria.

Which one of the following options represents the combination of all *correct* statements?

1. A and B only
2. A and C only
3. A, B, C and D
4. B and D only

Answer 2

The *Oral Polio Vaccine* is a live attenuated vaccine and is typically given to children, not adults. The *MMR vaccine* is given to protect against *Measles, Mumps,* and *Rubella*, not diphtheria.

Different segments of the renal tubule (Column X) and the sodium transporter in the apical membrane of tubular cells (Column Y) are listed below:

Column X		Column Y	
Renal tubular segment		Apical transporter	
a.	Proximal tubule	i	Na^+ channel (ENaC)
b.	Collecting duct	ii	Na^+-K^+-$2Cl^-$ co-transporter
c.	Thick ascending limb	iii	Na^+-Cl^- co-transporter
d.	Distal convoluted tubule	iv	Na^+-amino acid co-transporter

Which one of the following options represents the *correct* match between Column X and Column Y?

1. a-i, b-ii, c-iii, d-iv
2. a-ii, b-iii, c-iv, d-i
3. a-iii , b-iv, c-i, d-ii
4. a-iv, b-i, c-ii, d-iii

Answer 4

Isolated mitochondria were either treated with protease or first briefly incubated in hypotonic solution prior to treatment with protease. The reaction was stopped and samples were probed for presence of Mtg2, Porin (at the outer membrane), Cyt c (in the inter-membrane space) and KOH (in the matrix) using western blot analyses.

Based on the gels above, Mtg2 is localized

1. in the outer membrane facing the cytosol.

2. in the inter membrane space.

3. in the matrix.

4. traversing the inner and outer membrane.
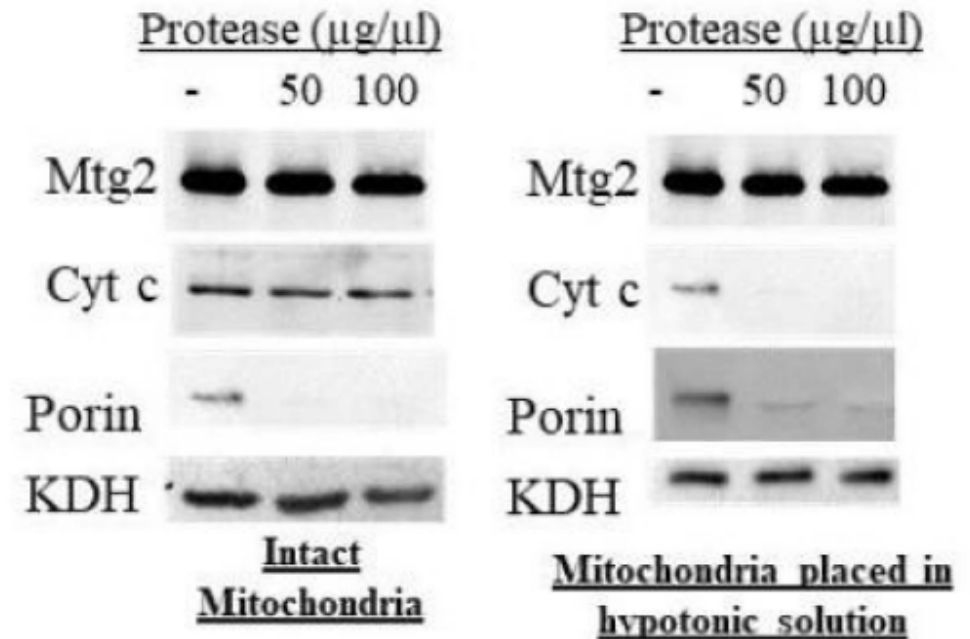
Answer 3

Mtg2 is a mitochondrial GTPase protein that plays a crucial role in mitochondrial ribosome assembly and function.
It present in the *mitochondrial matrix*.

A cancer cell line obtained from a rat glioma tumour was stained with the nuclear dye Hoechst 33342 and sorted using FACS. About 0.4% of the population stained lightly (LSP), distinct from the densely stained population of cells (DSP). Equal number of cells from these two populations were subcutaneously implanted into a suitable animal model to develop tumours. Following statements are made from this experiment:

A. The LSP cells will give rise to tumours.

B. The DSP cells will give rise to tumours.

C. The LSP cells can give rise to LSP and DSP cells.

D. The DSP cells can give rise to LSP and DSP cells.

Which one of the following options represents the combination of all *correct* statements?

1. A and D

2. A and C

3. B and C

4. B and D

Answer 2

It is common for tumorigenic cells (like DSP) to exhibit stem cell like properties and have the ability to give rise to various cell types, including progenitor types. LSP cells, if they are less differentiated, might not always be able to form tumors as effectively as DSP cells but could still have some capacity to generate different cell types under certain conditions.

Plants perceive effector molecules of a pathogen and mount a series of events that lead to the activation of a defense response. Following statements are made with respect to events that occur within a few minutes of the effector perception.

A. Transient change in the ion permeability of the plasma membrane.

B. Efflux of K^+ and Cl^- ions from the cell.

C. Influx of Ca^{2+} and H^+ ions into the cell.

D. Influx of K^+ and Cl^- ions into the cell and efflux of Ca^{2+} and H^+ ions from the cell .

Which one of the following options represents the combination of all correct statements?

1. A, B and C
2. A and D only
3. B and C only
4. A, B and D

Answer 1

Influx of K^+ and Cl^- ions into the cell and efflux of Ca^{2+} and H^+ ions from the cell: This statement is incorrect. The typical response involves the efflux of K^+ and Cl^- ions from the cell, not their influx. Similarly, Ca^{2+} typically influxes into the cell rather than effluxes during the early stages of pathogen response.

The following statements summarize metamorphosis and regeneration.

A. Many changes during amphibian metamorphosis are regionally specific. Although the tail epidermis never dies, the head epidermis does.

B. In neoteny, the juvenile form is slowed down, while the gonads and germ cells mature at their normal rate.

C. In epimorphosis, tissues never dedifferentiate into a blastema, divide, or re-differentiate into the new structure.

D. In the regenerating salamander limb, the epidermis forms an apical ectodermal cap. The cells beneath it dedifferentiates to form a blastema.

E. In hydras, there appear to be head activation gradients, head inhibition gradients, foot activation gradients, and foot inhibition gradients.

Which one of the following options has the correct combination of statements that will lead to normal developmental outcome in organisms?

1. A, C and D
2. B and D
3. A and E
4. B and C

Answer 2

A. During amphibian metamorphosis, the tail is resorbed, and the head undergoes significant changes, but it's not typically described that the head epidermis "dies." Instead, the tissue undergoes transformation to support the new adult structures. **C**. Epimorphosis is characterized by the formation of a blastema from dedifferentiated tissues, which then proliferate and differentiate to form new structures.

The lines (A to D) in the graphs represent trait relationships that capture the allocations of different tree species to their present reproduction versus present growth, and their offspring number versus offspring size.
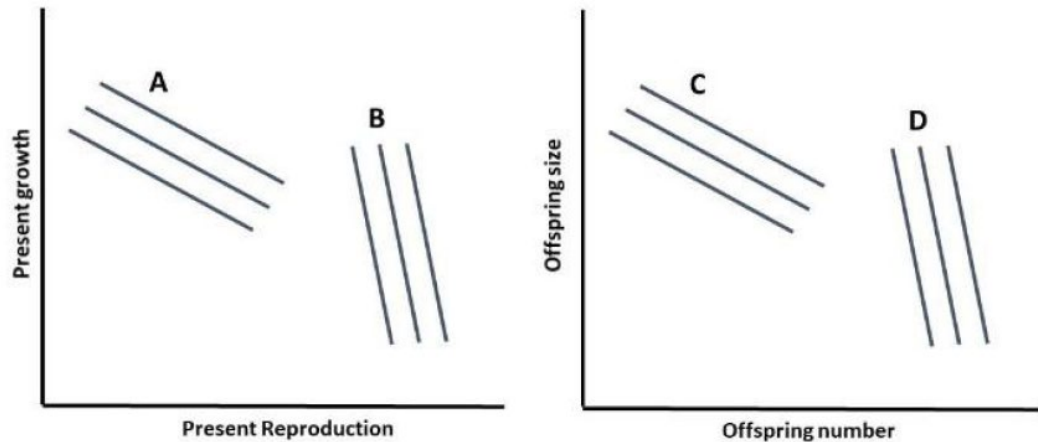
An isolated patch of forest land with nutrient-rich soils was recently cleared for timber. Which one of the options represents the correct combination of trait relationships that are most likely in the tree species that will invade and thrive in the early stages of secondary succession?

1. A and D
2. B and D
3. A and C
4. B and C

Answer 2

In the table given below, match the national parks with the mountain range in India where they are located.

	National parks		Mountain range
P.	Silent Valley	i.	Western Ghats
Q.	Neora Valley	ii.	Eastern Himalayas
R.	Valley of Flowers	iii.	Western Himalayas
S.	Pin Valley		

Which one of the following options represents all correct combinations?

1. P – i; Q – ii; R – iii; S – iii
2. P – ii; Q – iii; R – i; S – ii
3. P – ii; Q – iii; R – iii; S – i
4. P – iii; Q – i; R – ii; S – i

Answer 1
This question is information based.

The exponential growth equation *dN/dt* expresses the rate of population growth as the per capita rate of increase, *r* times population size *N*. This exponential model of population growth can be modified to produce a model in which population growth is sigmoidal by adding an element that slows growth, as population size approaches carrying capacity, K. If the per capita rate of increase r_{max} is the maximum per capita rate of increase, then select the correct option for the logistic equation for population growth.

1. $\dfrac{dN}{dt} = r_{max} \dfrac{(K-N)}{K}$

2. $\dfrac{dN}{dt} = r_{max} N \dfrac{(K-N)}{K}$

3. $\dfrac{dN}{dt} = r_{max} \dfrac{N}{K}$

4. $\dfrac{dN}{dt} = r_{max} \dfrac{K}{N}$

Answer 2

In a quad rat sample for tree species in a plantation, 20 species were found in almost equal abundance. The Shannon's index of diversity is approximately

1. 2.0
2. 3.0
3. 0.5
4. 1.0

Answer 2

$$H' = -\sum_{i=1}^{S} P_i \ln P_i$$

Here S = Total number of species in the sample (species richness).

P_i = Relative abundance of each species, calculated as the proportion of individuals of a given species to the total number of individuals in the community (n/N).

n = Total number of individuals of a particular species in the sample.

N = Total number of individuals of all species present in the sample.

For a situation where 20 species are found in almost equal abundance, each species would have a proportion close to 1/20, assuming the abundances are equal. Hence, p_i = 1/20 for each species

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Following are certain statements regarding NADP-malic enzyme type of C4 photosynthesis:

A.   Malate synthesized from oxaloacetate in mesophyll cells is transported to bundle sheath cells.

B.   Pyruvate formed in the bundle sheath cells is transported to mesophyll cells.

C.   Aspartate synthesized from oxaloacetate in mesophyll cells is transported to the bundle sheath cells and   again gets converted into oxaloacetate.

D.   Alanine aminotransferase converts pyruvate into alanine in the bundle sheath cells.

E.   Oxaloacetate is converted into aspartate, by aspartate aminotransferase in the mesophyll cell.

Which one of the following options represents the combination of all *correct* statements?

1.   A and B only

2.   B, C and E

3.   B and D only

4.   A, D and E

Answer 1
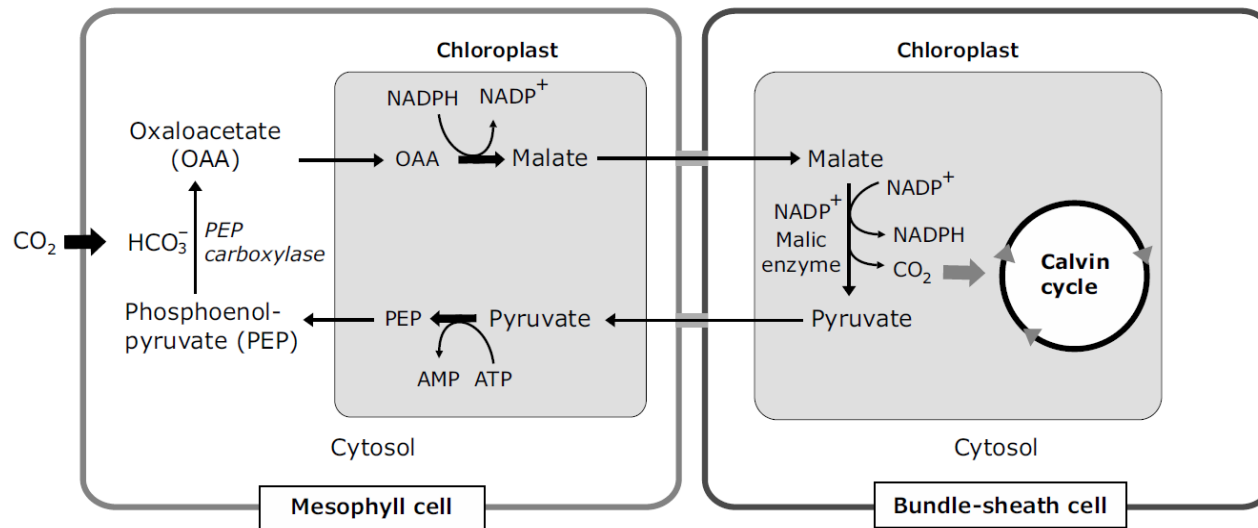
For detail you can consult **Fundamental and Practice, Life Sciences-1, 9th Edition**

https://pathfinderacademy.in/

The following statements are made regarding formulation of the advanced candidate antimalaria vaccine RTS,S.

A. It contains heat-killed *Plasmodium falciparum* sporozoites and Hepatitis B surface antigen.

B. It contains formalin-inactivated *Plasmodium falciparum* sporozoites and attenuated poliovirus.

C. It contains a fusion protein between *Plasmodium falciparum* CSP C-terminal region and Hepatitis B surface antigen.

D. It contains a fusion protein between *Plasmodium falciparum* Merozoite-surface protein and CSP.

Which one of the following options represents the combination of all correct statements?

1. A, B and D

2. B only

3. A and D only

4. C only

Answer 4

The RTS,S vaccine, also known as Mosquirix, is an advanced candidate malaria vaccine developed to protect against Plasmodium falciparum malaria. It is a recombinant vaccine that includes a fusion protein composed of the C-terminal region of the *Plasmodium falciparum* circum sporozoite protein (CSP) linked to the Hepatitis B surface antigen.

In hot environment, some changes occur in the human body to improve heat tolerance, which is called heat acclimatization. The following suggested statements describe the physiological adjustments during heat acclimatization:

A. Vasoconstriction starts in skin at a lower body temperature.

B. Salt concentration in sweat is increased.

C. The sweat secretion over the skin is more effectively distributed for optimum use of the effective surface area for evaporative cooling.

D. The sweat glands maintain high output for longer periods.

E. The threshold for start of sweating is increased.

Which one of the following options represents the combination of the correct statements?

1. A and B

2. B and C

3. C and D

4. D and E

Answer 3

Following are a few statements made regarding the *lac* operon.

A. The LacZ, LacY and LacA are encoded by a single transcript.

B. The three proteins are translated as a single precursor and then processed .

C. In the presence of glucose, lactose can upregulate the operon.

D. Isopropylthio β-D-galactoside (IPTG) is a gratuitous inducer.

Which one of the following options represents the combination of all correct statements?

1. A, B and D

2. A, B and C

3. B, C and D

4. A and D only

Answer 4

The lac operon includes the genes LacZ, LacY, and LacA, which are transcribed together from a single promoter into one polycistronic mRNA.

The polycistronic mRNA produced from the lac operon is translated into three separate polypeptides.

In the presence of glucose, the lac operon is not upregulated.

IPTG is a synthetic compound that mimics lactose and induces the lac operon, but it is not metabolized by the cells, hence it is considered a gratuitous inducer.

For detail you can consult Chapter 1 Genetics (**Fundamental and Practice, Life Sciences-2, 9ᵗʰ Edition**)
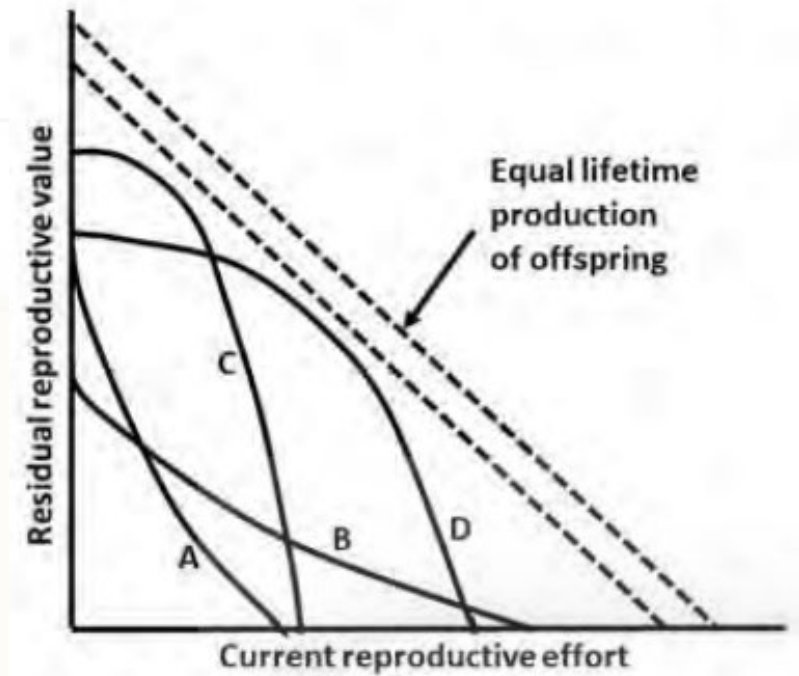
In the figure below, which of the curves that relate current reproductive effort with future reproductive value are likely to favor semelparous reproduction?

1. Curves A and C

2. Curves A and B

3. Curves B and D

4. Curves C and D

Answer 2

Semelparous refers to the type of reproductive event, in which organisms likely to breed only once during their lifetime. *Residual reproductive value* is a measure of the reproductive contribution at different ages through an individuals lifetime.

Certain statements are made below about hemoglobin.

A. HbA1c has glucose attached to the terminal valine in each β chain.

B. NADH-methemoglobin reductase system in RBC converts methemoglobin to hemoglobin.

C. O_2 binds to the Fe^{2+} in the heme moiety of hemoglobin to form oxyhemoglobin.

D. The affinity of hemoglobin for O_2 is much higher than that of its affinity for carbon monoxide.

Which one of the following options represents combination of all correct statements?

1. A and B
2. C and D
3. A and C
4. B and D

Answer 3

Oxygen does not dissolve easily in water, so only about 1.5% of inhaled oxygen is dissolved in blood plasma, which is mostly water. About 98.5% of blood oxygen is bound to hemoglobin in red blood cells. One hemoglobin molecule binds four molecules of oxygen, one per heme. Oxygen and hemoglobin bind in an easily reversible reaction to form **oxyhemoglobin**. The reaction between Hb and O_2 is an *oxygenation*, not an oxidation. Iron in Fe^{2+} state binds oxygen molecule reversibly; in the Fe^{3+} state it does not bind oxygen. Molecules such as CO and NO also bind to the heme

base, resulting in the creation of a stable **Amadori product**, known as **HbA1c**. It is important to note that the clinical measurement of HbA1c is specific to the glycation of *N*-terminal valine of β-chains, although the ε-amino group of *lysine* residues on the β-chains also undergoes glycation. Due to the continuous, gradual, and irreversible nature of

For detail you can consult Chapter 1 Biomolecules and Catalysis (**Fundamental and Practice, Life Sciences-1, 9th Edition**)   https://pathfinderacademy.in/

Match the major cell cycle regulatory proteins in Column {X) and their typical function in Column (Y)

	Column X		Column Y
A.	Wee1	(i)	suppresses G1/S-Cdk and S-Cdk activities after DNA damage
B.	p27	(ii)	phosphorylates inhibitory sites in Cdk
C.	p21	(iii)	activates APC/C in late mitosis and early G1 phase
D.	Cdh1	(iv)	suppresses G1/S-Cdk and S-Cdk activities in G1 phase

Which one of the following options represents the correct match between column X and column Y?

1. A-(ii), B-(iv), C-(i), D-(iii)

2. A-(ii), B-(i), C-(iv), D-(iii)

3. A-(iii), B-(iv), C-(i), D-(ii)

4. A-(iii), B-(i), C-(iv), D-(ii)

Answer 1

For detail you can consult *Chapter 3 Cell structure and Function* (**Fundamental and Practice, Life Sciences-1, 9th Edition**)
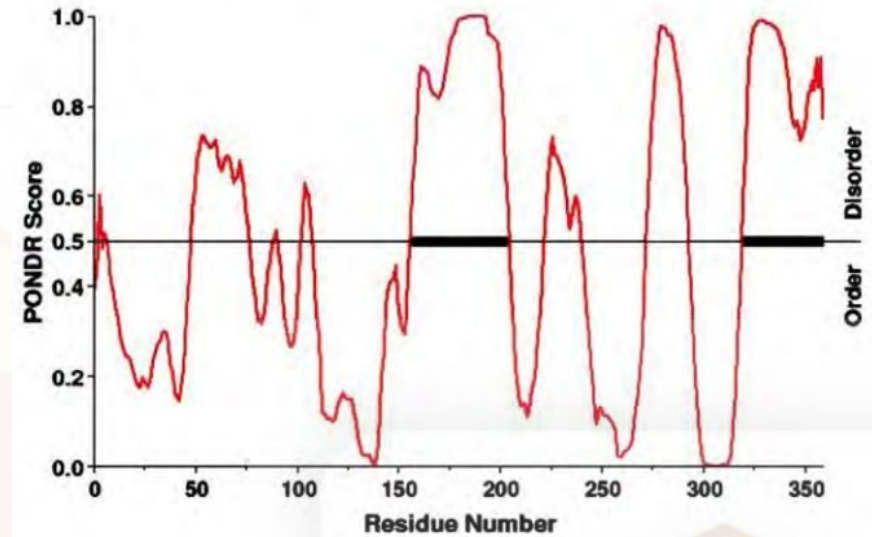
Given below is a PONDR (Predictor of Natural Disordered Regions) score-plot versus the protein sequence.

Based on the above figure, which one of the following statements is correct?

1. The protein has a folded domain in the middle with N- and C-terminal Flexible tails.

2. The protein is overall globular with almost no flexible linkers.

3. Both the N- and C-terminal regions are unstructured.

4. The protein contains multiple domains connected by flexible linkers.

Answer 4

A PONDR (Predictor of Natural Disordered Regions) score-plot is a graphical representation used to visualize the intrinsic disorder of protein sequences. The plot typically shows a line graph where the x-axis represents the amino acid sequence position (or residue number) of the protein and the y-axis represents the PONDR score, which quantifies the likelihood of a residue being part of a disordered region. Higher scores generally indicate a higher probability of intrinsic disorder.

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The steady state level of a plant metabolite 'M' is determined by the complex interplay of its biosynthesis, catabolism and transport processes from the source to the sink organ. A researcher tested following molecular and genetic strategies for engineering the metabolite 'M' in the native host plant.

A. Increasing catalytic efficiency of its rate-limiting biosynthetic enzyme in the source organ.

B. Increasing catalytic efficiency of the catabolic enzymes in the source organ.

C. Generating knock-out of the transporter protein in the source organ.

D. Repression of the catabolic enzymes in the sink organ.

Which of the above-mentioned strategies will provide a higher accumulation of the target metabolite 'M' in the sink organ?

1. A and B

2. B and C

3. C and D

4. A and D

Answer 4

Increasing catalytic efficiency of its rate-limiting biosynthetic enzyme in the source organ would increase the production of metabolite 'M' in the source organ. This will increase transport of M from source to sink. Repressing catabolic enzymes in the sink organ would reduce the breakdown of metabolite 'M' within the sink organ, allowing for higher accumulation.

Given below is the list of F-box proteins of the SCF ubiquitin E3 ligase complex (Column X) and their associated regulatory proteins of phytohormone pathways (Column Y).

Column X		Column Y	
A.	TIR1	i.	Degradation of JAZ repressor protein
B.	COI1	ii.	Targets the transcription activator EIN3 for degradation
C.	SLY1	iii.	Degradation of AUX/IAA repressor protein
D.	EBF1	iv.	Degradation of GID1-bound DELLA repressor

Which of the following combinations represents the correct match between Column X and Column Y?

1. A-i, B-iii, C-ii, D-iv

2. A-iii, B-iv, C-i, D-ii

3. A-iv, B-i, C-ii, D-iii

4. A-iii, B-i, C-iv, D -ii

Answer 4

TIR1 is an F-box protein that acts as a receptor for the plant hormone auxin. **COL1**: Functions in regulating flowering time by integrating light and circadian signals, affecting the timing of flowering based on environmental conditions. SLY1 is an F-box protein that functions as part of the SCF (SKP1-Cullin-F-box) E3 ubiquitin ligase complex. In the presence of gibberellins, SLY1 helps target DELLA proteins for ubiquitination.

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A decapeptide composed of MFTGPYCPRW was dissolved in 20 mM HEPES (pH 7.0), 50 mM NaCl, 50 mM Na₂SO₄, 5 mM OTT, and 4 mM EDTA. Which one of the following statements about the peptide in the given buffer conditions is correct?

1.   The peptide forms a dimer through disulfide bonds.

2.   The peptide has a net positive charge.

3.   The peptide has a net negative charge.

4.   The peptide is neutral.

Answer 2

M	Methionine	Charge 0
F	Phenylalanine	Charge 0
T	Threonine	Charge 0
G	Glycine	Charge 0
P	Proline	Charge 0
Y	Tyrosine	Charge 0
C	Cysteine	Charge 0
R	Arginine	Charge +VE
W	Tryptophan	Charge 0

The following statements are made about the killing of virus-infected respiratory epithelial cells by cytotoxic T cells:

A. Priming of the T cells has taken place in thymus, lymph node or spleen.

B. Viral antigens have been presented on infected epithelial cells.

C. MHC-1 molecules have been presented on infected epithelial cells.

D. MHC-11 molecules have been presented on infected epithelial cells.

Which one of the following options represents the combination of all correct statements?

1. B and C

2. A and C

3. B and D

4. C and D

Answer 1

Viral antigens have been presented on infected epithelial cells: This is essential for cytotoxic T cells to recognize and target infected cells. MHC-I molecules have been presented on infected epithelial cells: These molecules present viral antigens to cytotoxic T cells.
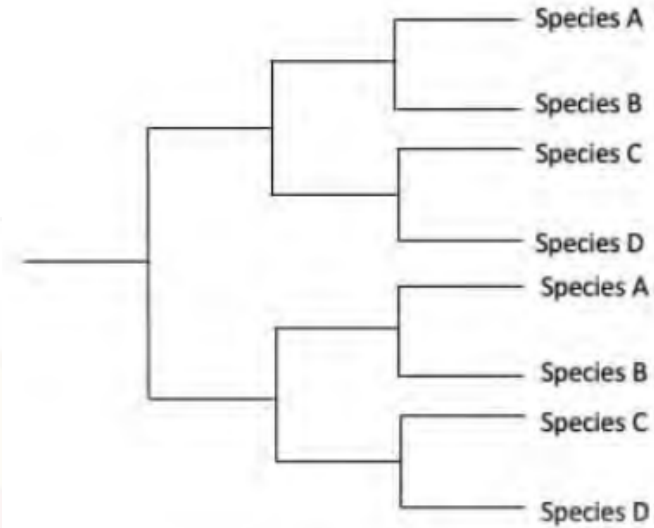
The following tree shows phylogenetic relationships between species A to D.

Which of the following molecular mechanisms would be responsible for the phylogenetic relationships shown between species A to D?

1. Gene duplication

2. Horizontal gene transfer

3. Hybridisation

4. Genome rearrangement

Answer 1

An enzyme has a K_m of 1 mM. Addition of different inhibitors changes K_m and/or V_{max} given as K_m^{app} and V_{max}^{app} (*app* for apparent), respectively. Which one of the following inhibitors will result in the lowest rate of enzyme-catalyzed reaction?

1.   An inhibitor with $K_m^{app} = 5K_m$

2.   An inhibitor with $V_{max}^{app} = \frac{V_{max}}{5}$

3.   An inhibitor with $K_m^{app} = 3K_m$ and $V_{max}^{app} = \frac{V_{max}}{2}$

4.   An inhibitor with $K_m^{app} = 2K_m$ and $V_{max}^{app} = \frac{V_{max}}{3}$

Answer 2
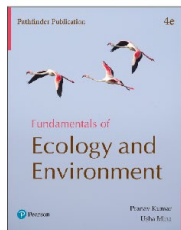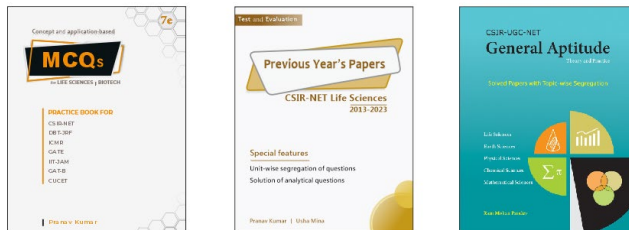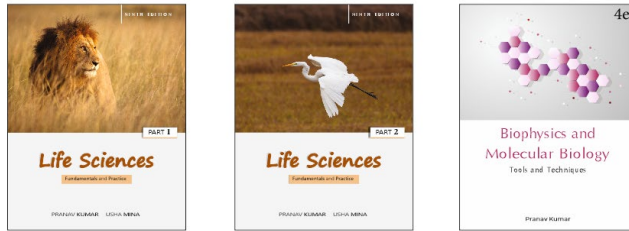
Changes in plasma osmolarity and extracellular fluid (ECF) volume affect thirst by separate pathways as given in the following statements.

A. Hypertonicity leads to osmoreceptor activation giving rise to hypothalamic control of thirst.

B. Hypertonicity leads to baroreceptor activation giving rise to hypothalamic control of thirst.

C. Hypovolemia leads to activation of baroreceptor and angiotensin II giving rise to hypothalamic control of   thirst.

D. Hypovolemia leads to osmoreceptor activation giving rise to hypothalamic control of thirst.

Which one of the following options represents combination of all *correct* statements?

1. A and C

2. B and C

3. A and D

4. B and D

Answer 1

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